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OF THE RESEARCH COUNCIL
OF ISRAEL

MIRIAM BALABAN
Editor

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FLAVOUR RECOVERY FROM ALICANT AND MUSCAT GRAPE JUICE

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ABSTRACT

A flavour recovery unit was built and tested. The feasibility of grape juice flavour recovery from two Israeli grape varieties was investigated. Utilization of natural grape juice flavours, obtained in the recovery unit, for the manufacture of soft grape drinks was also studied.

With the expansion of vineyard culture in Israel, other uses than winepressing have to be found for the surplus grape. One of these is the production of grape juice. Since it is impossible to store the juice in its natural form due to lack of facilities, it has to be concentrated. In such a process most of the highly volatile flavour and aroma may be lost; therefore, a flavour recovery process should be applied. Due to lack of low-temperature evaporating equipment, freezing equipment and low-temperature storage space, a frozen product is not feasible at present in Israel, so so that the well-known "cut back"[1] method cannot be used.

On the other hand, since the grape flavour and aroma components, unlike those of orange juice, are water-soluble and evaporate together with the water, they can be recovered from the concentrate. Based on this principle, Rice et al.[2] and later Eskew and co-workers[3-9] describe experimental units for flavour recovery of grape, peach, apple and berry juices.

The object of this study was investigation of the feasibility of grape juice flavour recovery from two Israeli grape varieties.

The quality of grape juice made from reconstituted concentrated juice with and without the addition of recovered flavour extracts was evaluated immediately and after storage periods of one and two months at room temperature. Unconcentrated frozen juice was used as control.

In addition, a soft grape drink containing only 30 percent juices with added syrup, acid, and recovered flavour extract was prepared and tested.

A. EXPERIMENTAL

1. *Equipment*

(a) *The flavour recovery unit and its operation*

The experimental flavour recovery unit used in this work (Figure 1) was built by Winter [10] based on the results of Walker's work[9].

Received November 30, 1960.

Its main parts are a feed pump, two heat exchangers and a fractionating column (A) attached to a cooler (B) and a reboiler (C).

The dimensions of the heat exchangers were: one 64″ long, 1/8″ I.D. stainless steel coil, and the other 31″ long, 1/2″ I.D. straight stainless steel tubing.

The fractionating column was filled with 125 mm long and 12 mm diameter glass tubing.

In order to operate the unit, distilled water was put into the reboiler (C) to about 1/3 of its capacity. The water was heated and all air expelled through the vent (E). After the fractionating column had been heated sufficiently, juice was pumped through the heat exchangers, operated at about 1 atm steam pressure, and flashed into the separating flask (F). Part of the juice was evaporated and left the separating flask for the fractionating column, while the remaining juice was cooled and collected for further concentration. As soon as the volatiles had filled the receiving flask (G), the recirculation pump (H) was started. After further concentration, the capillary valve (I) to the flavour extract receiving flask (K) was opened.

(b) *Evaporator*

A type 010 Luwa A.G. (Zurich) thin-film evaporator was used in this study. The juice was concentrated under vacuum at about 45°C.

(c) *Pasteurizer*

The pasteuizer consisted of a tubular pyrex glass heat exchanger, compising of two standard condensers in series. The juice was flash-pasteurized at 90°C. and filled hot.

2. *Preliminary experiments*

In order to test the flavour recovery unit, a 15% sugar solution containing 0.01% alcohol was used at different feed rates.

3. *Materials*

Juices from the Alicant and Muscat varieties were used in this work. The juice was obtained freshly pressed from the wine cellars of the Carmel Wine Growers' Cooperative, without any added preservative. All the juice was filtered through a 1.0 mm screen. A portion of the juice was frozen for control samples. The remaining juice was passed through the flavour recovery unit and further concentrated in the Luwa evaporator to 70° Brix.

4. *Preparation of grape juice samples*

In order to ascertain the efficacy of flavour recovery, three different samples of both juice varieties were prepared according to the following treatments:

(1) Fresh juice diluted to 16° Brix, flash-pasteurized at 90°C, filled, sealed and cooled.

(2) Reconstituted concentrated juice, prepared as described above, pasteurized at 90°C, filled, sealed and cooled.

(3) Same as sample 2, but with flavour extract from recovery unit added.

All samples were prepared twice during the season and tested in triplicate.

5. *Analytical procedure*

(a) *Organoleptic tests*

A set of 12 samples representing one complete replication was examined in each taste session. Each replication contained all three differently treated juices from both varieties, prepared twice during the season. The 12 samples were divided into 4 groups of 3 samples each. Samples were distributed in random order.

The taste panel consisted of 10 members previously selected by the triangular test method for suitability for organoleptic tests.

Each taster was required to score the samples using grades from −2 to + 2, with 0 as borderline but still acceptable. The taste panel was instructed to score all samples on flavour and aroma.

(b) *Quantitative chemical analysis*

The quantitative analysis of the flavour components in the extract was based on oxidation of organic compounds with an excess of potassium bichromate and iodometric determination of the unused bichromate[11]. The flavour concentration was expressed as ethyl alcohol, the latter being the main constituent according to Holley[12].

Concentration was determined with the aid of a hand refractometer and expressed as degrees Brix.

(c) *Statistical treatment of results*

A total of 108 grape juice samples was included in the study, as well as 15 soft drink samples. The organoleptic scores for aroma and flavour were tested by analysis of variance in order to evaluate the effect of the factors studied.

6. *Preparation and testing of soft grape drinks*

An additional object of this work was testing the efficacy of recovered natural flavours in the manufacture of soft drinks. Based on preliminary experiments and economic considerations, drinks containing 30% natural juice, standardized with 70% sucrose syrup containing 0.8% tartaric acid to 18° Brix, were prepared.

Four different samples of soft drink were prepared as follows:

1) without flavour additives;
2) with recovered flavours added;
3) with synthetic flavours added;*
4) with both synthetic and recovered flavours added.

All samples were flash-pasteurized at 90°C, filled, sealed, and cooled.

* The synthetic flavour was prepared and added in the following optimum combination:

Ethyl cinnamate	15 ppm
Methyl anthranilate	25 ppm
Ethyl alcohol	75 ppm

The soft drink samples were tested organoleptically in triplicate by a panel of 9 members. A sample of commercial undiluted pasteurized grape juice served as control.

B. RESULTS AND DISCUSSION

1. *Preliminary experiments*

Operating the flavour recovery unit with a 15% sugar and 0.01% alcohol solution, 40% of the alcohol was collected in the flavour extract receiving flask, 30% in the reboiler and 30% remained in the sugar solution. The sugar solution was concentrated from 15 to 17° Brix, while the alcohol content of the flavour extract was 3.5 percent.

Preliminary trials with the recovery unit showed that at a feed rate of 0.5 l. juice per minute, 30 ml flavour extract per litre juice were obtained. The flavour extract contained about 3.5% flavour components. In this process, the juice was concentrated by about 10%.

TABLE I

Analysis of variance

Source of variation	Degrees of freedom	Sum of squares		Variance	
		Flavour	Aroma	Flavour	Aroma
Varieties (V)	1	544.5	684.0	544.5	684.0
Seasonal periods (S)	1	641.7	90.0	641.7	90.0
Storage periods (P)	2	1003.2	130.5	501.6	65.2
Treatments (T)	2	5136.3	3124.8	2568.1	1562.4
Interactions:					
V × S	1	11.1	34.5	11.1	34.5
V × P	2	68.7	33.3	34.3	16.7
V × T	2	105.4	160.8	52.7	80.4
S × P	2	25.8	62.4	12.9	31.2
S × T	2	105.9	34.6	52.9	17.3
P × T	4	32.7	1.8	8.2	0.5
V × S × P	2	883.8	59.2	441.9	29.6
V × S × T	2	392.2	35.7	196.1	17.8
S × P × T	4	72.0	248.4	18.0	62.1
V × S × P × T	4	8523.0	10633.5	2130.8	2658.4

2. *Evaluation of grape juice samples*

The results of the analysis of variance for the average aroma and flavour scores from the taste panel are summarized in Table I.*

Since the variance for the experimental error (the interaction between the four factors — variety, treatment, season and storage) was high in relation to that of the individual factor, no conclusions could be drawn from this table. It was therefore decided to analyse the data excluding storage period and time of season as separate factors.

Table II summarizes the analysis of variance of the effect of grape juice varieties and treatments on the flavour and aroma of the juice.

In this case there are highly significant differences among the three treatments with regard to both the flavour and aroma scores. In addition, there exists a significant difference in the aroma scores between varieties.

TABLE II

Analysis of variance. The effect of two factors on two quality variables of grape juice

Source of variation	Degrees of freedom	Sum of squares		Variance	
		Flavour	Aroma	Flavour	Aroma
Total	5	34496.0	23059.9		
Varieties (V)	1	3266.7	4103.2	3266.7	4103.2*
Treatments (T)	2	30817.0	18750.3	15408.5**	9375.1**
V × T	2	412.3	196.4	206.1	98.2

* Significant at 95% confidence level

** Significant at 99% confidence level

Table III shows the effect of treatments of grape juice on the total flavour and aroma scores.

There was a significant difference in flavour scores between the fresh juice and both the reconstituted juices with and without flavour added. However, no difference was found between the latter two.

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* It had been necessary to take averages owing to changes in the composition of the taste panel over the period of this study.

TABLE III

The effect of treatment on the total flavour and aroma scores of grape juice from both varieties

Treatment	Flavour	Aroma
Fresh juice	137.5	146.5
Reconstituted juice	37.5	11.2
Reconstituted juice with added flavour	38.0	101.0
L.S.D. for 99% confidence	84.1	58.0

With regard to aroma, there was a significant difference between both the fresh juice and the juice with added flavour on the one hand and the juice without added flavour on the other. No such difference was found between the first two treatments.

This means that the fresh juice was preferred with regard to taste to reconstituted juice, regardless of flavour addition. However, the aroma of fresh juice was not significantly better than that of reconstituted juice with added flavour, but the aroma scores of both were better than that of reconstituted juice without added flavour.

3. *Evaluation of soft drink samples*

Four samples of soft drinks, prepared as described previously, were compared with a commercial sample.

The analysis of variance (Table IV) showed no significant differences between samples. In other words, the taste panel neither preferred any of the four tailor-made soft drinks nor singled out the commercial 100% graph juice as superior.

Most members of the panel commented on the undesirably high sweetness (about 18% sugar) of the juice, which probably dulled their taste sensitivity.

TABLE IV

Analysis of variance. The effect of four methods of preparation on the flavour and aroma of grape soft drinks

Variation	Degrees of freedom	Sum of squares		Variance	
		Flavour	Aroma	Flavour	Aroma
Total	14	44.74	55.97		
Between groups	4	25.74	16.64	6.44	4.16
Within groups	10	19.00	39.33	1.90	3.93

C. SUMMARY AND CONCLUSION

An experimental unit for flavour recovery was tested and found to strip 40% of the initial flavour compounds and concentrate them to 3.5%.

Analysis of variance of organoleptic evaluations of the grape juice showed a highly significant difference in flavour and aroma scores between the juices with and without added natural flavour. There was also a significant difference in the aroma of the two grape juice varieties tested.

Fresh pasteurized juice was scored higher than reconstituted juice with added natural flavour extract, which in turn was significantly better than the same juice without added natural flavour.

No significant difference was found in grape drinks containing 30% natural juice, with and without natural or synthetic flavours, either between themselves or between them and a 100% natural pasteurized grape juice. There was a slight tendency in favour of the grape drink sample containing both natural and synthetic flavour extracts.

ACKNOWLEDGMENT

The financial support of the Carmel Wine Growers' Cooperative is gratefully acknowledged.

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NEW METHODS IN REFINING SOYA OIL AND OTHER OILS

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1. INTRODUCTION

There have been no startling advances made in the field of refining during the last twenty to thirty years except in developing new methods of neutralization, which is perhaps the most important stage of refining because oil lost in the neutralization process can never be recovered. We have had the development of the vacuum bleacher and some attempts to make continuous bleaching work, though the latter process has not been generally accepted. There have been minor developments in hydrogenation machinery and equipment but there has been the development of the continuous and the semi-continuous deodorizer, but again those developments were an adaptation of equipment used in other industries.

However, in neutralization, various methods of continuous refining have been developed which have superseded the old batch kettle in the U.S.A. and in many other countries and I propose to deal with four new methods of refining soybean oil and other oils.

2. THE RINI PROCESS

The first method is a kettle process which was developed especially for the refining of soybean oil, about 11 years ago. It is a method of refining crude soybean oil, particularly degummed soybean oil, which has always given trouble in continuous operation, and depends upon the addition of a small amount of an additive to the refining caustic or lye, the additive which has been found to be most successful being tetra-sodium pyrophosphate. By this method it is possible to obtain very high yields of excellent refined oil. In fact, the yields by the tetra-sodium pyrophosphate methods are just about the same and in some cases marginally superior to those which can be obtained by continuous refining. The process is called the Rini Process and its principle is not as yet clearly understood. The procedure is to add a small amount of a 10% solution of tetrasodium pyrophosphate to the oil in the

refining kettle after it has been heated with agitation to 55°—56°C; the calculated amount of lye is then added in the form of a 16° Baume solution. For the gummed oil an excess of approximately 0.1% dry sodium hydroxide based upon the oil is used. Heating of the kettle is continued until a temperature of 80°C is reached at which point there is a clear break or separation of soapstock. Then hot water is added in the form of a still wash—in the case of degummed oil 5% of the total volume— and the mass is allowed to settle. The rest of the operation consists merely of the withdrawal of the soap stock, followed by subsequent still washes, usually two, and the results obtained by that method will—I personally have usually operated on degummed oil containing about 0.5—0.6% free fatty acids—give an average yield of 99.15%. The same process with slight modification can be used on crude soybean oil but has not been adapted for use on crude cotton oil so far. Although I have worked out a method of doing it with cotton oil, it has not been tested on a large scale and I am unwilling to recommend any process for commercial operation no matter how good it appears in the laboratory, until I have had an opportunity of testing it on 30—50 tons of oil.

For soybean oil, it is my considered opinion that the best method of continuous refining is the standard caustic process, where the oil is refined once with caustic soda, given a sufficient amount of lye to purify it, remove the fatty acids and the impurities, and is then washed and dried. I have had a great deal of experience in attempting to improve the colour of soybean oil by increasing the amount and excess of lye and have even attempted to re-refine it. The greatest improvement that I have been able to obtain on a soybean oil, which was properly neutralized in the first place, was an approximate decrease of 0.2 red Lovibond units in the bleach colour, and in my opinion such a minor improvement is not worth the additional loss which is always involved in two step refining.

3. THE AMMONIA PROCESS

The ammonia process has been installed in only one soybean plant in the U.S.A. This particular refinery, does not manufacture finished oil. It merely refines the oil for export, and the degumming is carried out with ammonia.

One of the characteristics of ammonium soaps is that they will decompose quite readily under heat, so that when the mixture of gums and soap which is obtained by treating the oil with liquid ammonia, is transferred to a closed kettle, and the ammonia and moisture are driven off, a residual mixture of lecithin, fatty acids and a small amount of triclyceride remains. This can readily be added as a fatty supplement to soybean meal.

In theory the ammonia process should be capable of application to cotton seed oil, but it seems that in refining cotton seed oil it is necessary to refine a second

time with caustic, after the ammonia treatment, and the results do not seem to be entirely satisfactory, either as to oil quality or as to yield, and therefore I would not recommend the ammonia process for the refining of cotton seed oil.

4. THE CAUSTIC SODA ASH PROCESS

Of all the two-stage refining processes which are available in the United States, the caustic soda ash process is probably the most effective, particularly on cotton seed oil. In this process, crude oil, is heated to about 40°C and is then mixed with the exact theoretical quantity of caustic soda required to neutralize the free fatty acids, the mixing being carried out continuously. The mixture of oil and caustic then flows to a second mixer in which a proportioned amount of soda ash is added usually 3—4%, with the aim of reducing the free fatty acids to levels under 0.1 per cent. The mixture of soda ash, caustic, soap and oil is then continuously separated, after being heated to a temperature of about 70°C.

The refined oil or neutralized oil goes forward to a second refining stage where it is cooled to about 80°—90°F, is then treated with a small percentage of very strong caustic soda, usually 32° Baume, heated and then reseparated in a second battery of centrifugal separators. The refined oil is then continuously washed.

It is the contention of the developers and promoters of the caustic soda ash process that it is of great value because it is possible to take the soapstock from the primary machines, that soapstock which contains the soda ash, and add it directly to cotton seed meal or to soybean meal for cattle or poultry food as a fatty supplement. In order to obtain a very heavy soapstock of small volume and which can be easily handled, the original refining is carried out with lye of 30 degree Baume strength and the soda ash is about 20 degree Baume strength. The yields in this process are excellent, the increase in yield over normal caustic refining of cotton seed oil by the caustic soda ash process being approximately 0.75 percent. It is also possible to equal or even better the bleachability of the refined oil as measured by the standard AOCS tests.

However, there are disadvantages to the process. It is more complicated than some others. It requires special apparatus and instrumentation and so far most of the refineries in the United States have decided that they would prefer to continue using their standard caustic refining methods.

In my opinion in the refining of soybean oil the caustic soda ash process is of no value whatsoever.

5. MISCELLA REFINING

Miscella refining merely means the refining or neutralization of a crude oil in the Miscella from the extractors in solvent extraction plants. This process has been used in two refineries in the U.S.A. One firm developed the process because they found that oil extracted by the full extraction process had most desirable properties

in yield and finished colors when freed from hexane, but that after it had been stored for some time losses went up and the colour darkened. However, if it was refined in the Miscella on the spot, it was possible to achieve low losses and very excellent colour; that is to say from 5 yellow, 0.5 red to 10 yellow, 1 red on a 5¼ inch column. If the oil was allowed to age before refining bleach colour was liable to go up to 30 yellow, 3 red a 5¼ inch column.

In order to refine in Miscella, it was found necessary to do two things. In the first place, the hexane content has to be reduced to such a point that the Miscella treated contained approximately 50 percent hexane and 50 percent oil by weight. The reason being that if the entire Miscella were to be refined a large quantity of material would have had to be handled.

Secondly, it was found to be very difficult to obtain intimate contact between the caustic soda and the oil, or rather between the caustic soda and the free fatty acids and coloring matter of the oil, when the oil was so diluted with solvent. This problem was solved when it was found that if a very small amount of polyethylene oxide ethers was added to the lye, good contact between the caustic and the fatty acids and colouring matter of the oil was obtained, resulting in a good separation.

The second plant in the U.S.A. in which Miscella refining is used is a pre-press solvent mill. Pre-pressing is carried out at relatively light pressures and the pre-pressed oil is set aside. The expeller cake is then extracted continuously in a modified Bonatto extractor, and the Miscella from the extraction column mixed with the pre-pressed oil to give a concentration of approximately 42 percent by weight of oil in the hexane. Instead of using an additive like polyethylene oxid ethers the firm operating this process makes use of a homogenizer, operating at a pressure of about 1,500 pounds per square inch which acts quite efficiently in bringing the oil and the caustic into contact.

The homogenizer used costs over $11,000 and there is considerable expense involved in installing it. I have worked with other types of agitators and do not think that for pre-pressed cotton oil and the Miscella from extraction of the cake, it is necessary to spend the sums involved in purchasing and installing a homogenizer. There are a number of mixers on the market which are probably capable of doing the job. This process also gives very good colour and the yields, in so far as they can be determined, are good.

One of the big problems of the firm operating the process is the character of the soapstock. It is a very difficult matter to neutralize Miscella soapstock, or to split it with sulphuric acid, because of the development of heat which causes foaming and a lot of trouble. So they have minimized their difficulties by taking the soap stock directly from the primary centrifuges and adding it to the extracted meal, selling it together with the meal as an additional nutritive component of their finished cattle feed.

There is no reason to applyMiscella refining to soybean oil, and there are a number of reasons for this. First of all if one attempts to emulsify or homogenize a crude soybean oil from the extractors, it is impossible to remove the lecithin and phosphatides. The net result is that instead of obtaining a refined oil, one gets a refined oil containing most of the original lecithin and very little fatty acid, which must be treated with caustic in order to remove the lecithin. On the other hand, well degummed oil containing no lecithin can be Miscella refined but the oil cannot be degummed in Miscella for the simple reason that soybean lecithin and gums are practically 100% miscible with petroleum solvents. The process may be carried out by using a special additive, but I feel there is no advantage in the process.

PROPER PROCESSING OF SOYBEANS AND COTTONSEEDS TO OBTAIN MAXIMUM BENEFIT OF THE PROTEINS

AARON ALTSCHUL

F. A. O. Adviser

1. INTRODUCTION

The amount of protein that can be got out of a soybean has an upper limit which is set by genetic factors which determine not only the percentage of protein but also its amino acid composition, and so far geneticists have not been successful in changing radically the amount of protein in soybeans or its amino acid composition. The same is true for cottonseed. The same is true not only for the protein content and the protein composition but the same is true also for the other materials in the oilseed which affect favourably or unfavourably its use as a source of protein for man and animals. For instance, no success has so far been achieved in breeding out the ricin which is a toxic component of castor beans. There is some evidence that it will be possible to breed gossypal out of cottonseed, but this may take a considerable time so that in general the processor has to work with the raw materials at present at his disposal.

On the other hand, the processor can take full advantage of the material contained in oilseeds by conducting his processing operation in such a way as to obtain maximum benefit and of course the same holds true for the users and the feeders whose job it is to use the materials in such a way as to derive the maximum benetit possible from them

2. SOYBEAN PROCESSING

The first step in the processing of the soybean is the cracking of the bean to loosen the kernel from the hull. At this point the operator must decide whether to separate these two components or not. If the components are not separated a soybean meal is obtained that contains 45—and I have seen some analyses of 46 percent—protein when the oil is removed. If the hulls are separated, which can be done by conventional equipment, the final meal will contain 50 percent protein or more. The importance of the decision to be taken is connected with the fact that in production of feed for poultry and of protein supplements for man, the amount of fibre in the dict is important, while as far as cattle-feed is concerned the fiber-content is not very important.

The next step in processing is the solvent extraction operation. For this step continuous equipment is the most efficient. There is one critical point in the extraction of the oil which affects the meal, and that is the use of trichlorethylene as the solvent For extracting the oil from the soybeans – Several years ago in the Untied States there was quite an outbreak of what was called "x" disease in cattle fed soybean extracted with trichlorethylene. The use of trichlorethylene has obvious advantages from the point of view of safety, but there is a reaction between the chlorine in trichlorethylene and some of the sulphydryl groups in the protein of soybeans to yield very toxic materials. As a result the practice of using chlorinated solvents for soybean processing has ceased completely in the United States and I would not recommend the use of chlorinated solvents for oilseed extraction unless thorough investigations show that these problems will not arise.

The third step is desolventizing and toasting. In some plants this is done as one operation and in others it is done as two separate operations: first the solvent is removed and then the material is toasted.

There are two problems involved in the handling of oilseed materials intended for sensitive animals like poultry and man: (1) to maintain the maximum protein value in the materials, and (2) to destroy toxic and interfering substances.

The protein in the meal is not good unless it is available for digestion by the animals. In a meal like soybean meal, which contains both proteins and carbohydrates, so-called browning reactions can take place. These are reactions between the sugar and certain groups in the proteins which tie up those groups and render them less available for digestion; hence, it is possible to produce a 50 percent soybean or cottonseed meal that analyses 50 percent protein, but, if overheated, the protein will have no nutritional value and the animal eating it will be starved for protein.

So, one of the objectives of processing these meals is to keep the temperature at a minimum so as to prevent destruction of protein. Unfortunately there is a difficulty in the case of soybean meal; there are materials in the soybeans which even though they are not necessarily toxic nevertheless interfere with the digestive process so that raw protein, which should have the highest protein value if one considers browning reactions, is not available to poultry in the raw soybean. There is a lot of difference of opinion among scientists as to exactly why it is unavailable, but that is unimportant to our discussion.

As the toxic materials are more sensitive to heat than the proteins themselves, just enough heat is applied in the toasting process to destroy these so-called inhibiting materials but not enough to destroy the protein. In other words, enough heat is applied so as to reach the maximum protein value, and this can be determined by feeding experiments, which are expensive and of long duration, or by various chemical methods. At any rate, *the critical step in terms of the processing of soybeans aor poultry is in the toaster—which usually is some sort of a stack cooker—and in the fmount of heat applied in the toasting operation.*

3. COTTONSEED PROCESSING

The processing of cottonseed raises similar problems concerning protein quality, etc., and toxic materials. If one is interested in cottonseed meal of a superior quality that would be suitable for mixing with soybean meal in the feeding of poultry and would be of a suitable quality for feeding to humans. But in this case the problems are handled in an entirely different way.

The cottonseed is oval-shaped and its kernel contains dots which are a unique phenomenon in seeds. These dots are usually called pigment glands, and contain gossypol which is a unique chemical that is found only in cottonseed and is toxic to monogastric animals.

The first stage in processing is again the separation of the kernel and the hulls and here again the processor must decide if he wants materials to be used in cattle or poultry feeding. If nothing is done to remove the hulls, the cottonseed meal will contain 41–42 percent protein. If the hulls are removed the meal will contain 45 percent protein or more. It has been determined here in Israel and elsewhere that for a number of reasons cottonseed meal for poultry should contain at least 45 percent protein, one of the reasons being that if it is to be mixed with soybean meal, one cannot afford to have too great a discrepancy in protein content between the two materials. It is also possible to make a 55 percent protein cottonseed which can be fed successfully to humans.

Whereas the soybean kernel contains about 18 percent oil the cottonseed kernel contains about 33 percent. Direct extraction of cottonseed would cause a lot of mechanical difficulties because there is so much more oil that the structure is weaker and fines are produced. The idea behind processing cottonseed is to convert the cottonseed into a material that can be further processed like the soybean, by first removing the excess oil. This method processes a number of interesting advantages apart from the fact that it solves the mechanical difficulties. The procedure is to take out the bulk of the oil by screw presses leaving a material that contains about 10 percent oil; the residual oil can then be extracted by solvent extraction to yield the final cottonseed cake. In the United States the practice is to do all of the prepressing in one operation. In Israel the process is carried out in two steps, and in my opinion this is a better method as it causes less heat damage to the proteins, which can lose their protein value just like the soybean proteins. If the operation is carried out in one stage, the pressure of the screw press may generate such an intense heat as to destroy the protein. If it is done in stages and not so much heat is developed in either stage, it is possible to achieve a product with a much better protein value.

It may be added that the pressure developed in screw-pressing ruptures the pigment glands and releases the gossypol, part of which goes into the oil while part is bound to the meal, with the result that prepressing produces a meal that can be fed to poultry without too much trouble.

The next stage is solvent extraction of the cottonseed cake, and this should be done as quickly as possible. Every day that cottonseed cake lies unprocessed there is an increase in free fatty acid content and there is an increase in color which cannot be removed by refining so that there is a decrease in the quantity of the oil and also in its quality.

Solvent extraction leaves us with the meal and the oil. In this process the meal does not have to be toasted because the toxic materials are different from those in the soybean. Here one has the gossypol problem which is an entirely different one.

Just as solvent extraction should be carried out as quickly as possible so should crude cottonseed oil be refined as soon as possible, because storage of crude cottonseed oil multiplies and increases the problems. We have made tests in our laboratory on the removal of gossypol from cottonseed oil, and have found that we can remove the gossypol immediately from fresh cottonseed oil, but that after it has stood for a week, it is impossible to recover the gossypol derivatives from the oil. Derivatives of gossypol interact with the fats and form compounds that are so close in their properties to lipids that the refining operation which seeks to separate lipid from non-lipid material finds it more difficult to separate these pigments. *So that it may be said that one of the simplest and easiest ways of getting the highest quality out of cottonseed oil is not to delay removal from meals or refining.*

Cottonseed contains about 0.7—1.4 percent gossypol, in the raw kernel. If the seed were only to be solvent extracted a meal would be obtained containing what is called "free gossypol", that is gossypol that is almost all contained in the pigment gland unbound. This material is harmful to poultry, and quite possibly to humans, although there is no evidence for this.

When cottonseed is processed by the pre-pressed solvent extraction process, the free gossypol is reduced to 0.04–0.07 percent and we have determined that this range of free gossypol is safe for poultry and humans, though the amount of heat damage caused to the protein by this method still remains to be determined.

In this connection I might mention that in Guatemala where there is no milk and practically no animal protein, a simple inexpensive vegetable protein mixture, was designed that could be used to cure children of protein deficiency diseases. The mixture was made up of 33 percent cottonseed containing. .04 to .07 percent free gossypol and 55 percent protein and 67 percent corn-flour plus about one percent of yeast and a few vitamins. This mixture was fed to infants suffering from severe protein malnutrition. In six weeks, without using anything else as the source of food but this simple mixture, these children were totally cured. This shows what possibilities these materials possess as sources of protein for highly selective animals having very sensitive protein requirements.

4. REPLACEMENT OF FISH MEAL IN POULTRY FEED

In Israel, fish meal is still an important part of the poultry diet. In the United States, it has been found that it is necessary to add only very little animal protein to soy-

bean-corn diets for poultry, just enough for an adequate supply of vitamin B^{12}, which can be added in any one of a number of other ways that are well-known in Israel.

I think there are two things that are wrong with the present practice of adding fish meal. First of all, the fish meal is expensive. Secondly, the fish meal is of varying quality and since no method is available for testing the quality of the fish meal which is also subject to heat damage it is possible that the fish meal sometimes has zero protein value and since it is not made in Israel, there is no control over its processing.

Furthermore, the use of good fish meal means that it is not important to use very good soybean meal, which means that all the time being devoted to processing soybean meal so as to attain the best possible protein quality is being wasted.

I should think that it is possible to add much less fish meal to the poultry feed in Israel and yet to obtain diets which would give the same poultry performance. Such a change would reduce imports and lower the cost of producing poultry. I also think that cottonseed meal which at present is used entirely for cattle could be used for poultry too, if properly processed and I have suggested experiments along these lines.

To accomplish these aims, high quality products of standard quality are needed and also methods of analysis capable of determining the quality of the meals produced.

Finally, there must be experiments to demonstrate to the poultry industry how these things can be done; how poultry can be grown with less fish meal, and how cottonseed meal can be used for poultry feed.

THE UTILIZATION OF SOYBEAN OIL MEAL AS POULTRY FEED

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1. "TOASTING" OF SOYBEAN OIL MEAL

"Toasting" may be defined as the additional heating of the meal over and above that necessary for the driving off and recovery of the organic solvent. The effect of such heating depends on the temperature used, the duration of the treatment, and upon the amount of moisture present. Of these three factors, the amount of moisture seems to be the most important, because moisture allows us to be satisfied with a lower temperature or with a shorter period of heating. Or, in nutritional terms, in the presence of moisture the undesirable or even toxic factors of soybean meal are destroyed before the nutritional quality of the protein in the meal is affected.

The necessity for "toasting" soybean meal may possibly depend on the age of the chickens for which the feed is intended. As far as chicks are concerned, "toasting" has been accepted in the U.S. for many years, and in Israel during the past few months. Reports published in the U.S.A. and biological tests performed at the Israel Agricultural Research Station have shown without any doubt that it is essential to "toast" soybean meal that is to be utilised as chick feed. Strange as it may seem, there are still some progressive countries in Europe where "toasting" has not been accepted as yet.

With regard to the nutrition of the adult laying chicken, the published literature is rather meagre. Moreover, these research reports compare raw with fully-toasted meals, while in Israel we are interested in comparing under-processed with well-toasted meals.

Research on this subject is in progress at our local Agricultural Research Station, and preliminary experiments, as yet incomplete, seem to indicate that full toasting may be unnecessary, though it is too early to reach conclusions.

2. DEHULLING OF SOYBEAN OIL MEAL

While there is no longer any discussion in Israel as to the importance of "toasting" for the nutrition of chicks, there are many divergent opinions on the place of dehulling in the production of soybean meal. Soybean meal is used as feed because of

its protein content, and since this protein is not affected by the dehulling process, the process cannot possibly have any influence on the protein quality. All it does is to give us a more concentrated product.

The advantages of using dehulled meal are as follows:

a) By using a more concentrated protein supplement we can employ more grain in the composition of the ration, and this makes for a diet richer in energy. This advantage may amount to 3 calories (of net energy) per 100 grams ration, which is about equivalent to the addition of 0.5 percent fat to the ration, and which in turn might improve feed conversion by 1–2 percent. This does not sound much, but mounts up in the long run.

b) Since the meal is more concentrated by approximately 10 percent, 10 percent may be saved in transport, in sacks, and in storage space.

c) Last, but not least, with the modern machinery at the disposal of our manufacturers, they are able to produce a 45 percent meal without removing dirt and other contaminants. On the other hand, production of a 50 percent dehulled meal compels them to give the beans a through cleaning before processing them.

The disadvantage of the dehulled soybean meal is its expense. Naturally, if the price *per unit protein* does not change, there is a great advantage in the dehulled meal for the poultry industry, as explained above. If this meal should be slightly more expensive (again per unit protein), it might be worth while to use it for chicks (which are more sensitive to a dirty meal, and respond better to an increase in the energy level of the diet), while saving this extra expense in connection with laying chickens. However, should this meal be decidedly more expensive per unit protein, despite the sale of the hulls to the cattle industry, then the poultry industry will not be able to afford a dehulled meal.

3. SOYBEAN OIL MEAL AS A SUBSTITUTE FOR FISH MEAL

I would venture to predict that the chances of replacing fish-meal by soybean oil meal are rather good. As a matter of fact, we started the process by changing over from a 10 percent fishmeal diet to a 6 percent fishmeal diet for chicks, when toasted soybean meal became available in Israel a few months ago. Fishmeal has several advantages over soybean meal, the chief ones being:

a) Its mineral content (which in Israel can easily be supplied from much cheaper sources).

b) Vitamins, especially riboflavin and vitamin B_{12} (which are available inexpensively as synthetic products).

c) Protein quality.

d) Unknown growth factors.

As far as protein quality is concerned, this is just another term for amino acid composition. In this respect soybean meal is considered very good except for its partial deficiency in methionine, which lately has become available commercially and at a reasonable price as a synthetic compound.

With respect to the forementioned unknown growth factors, this is a problem on which investigators are not in agreement as yet, and additional studies on the advantages and economy of these factors are required.

At present, at the Israel Agricultural Research Station, we are trying to find out, in experiments both with chicks and laying chickens, to what extent fishmeal can be limited as an essential protein supplement, and what is the role played by methionine in this connection.

Now a last word to the manufacturers: this substitution of fishmeal by soybean oil meal will only be possible if the latter is of the highest quality, as far as processing is concerned, and it should preferably be a dehulled meal, lest we lose too many calories by substituting a much less concentrated protein supplement for fishmeal.

SPECTROPHOTOMETRIC RESEARCHES IN EDIBLE OILS AND FATTY FOODS

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1. ADULTERATION OF OLIVE OIL

The quality characterization values of olive oil are related to the specific absorption coefficients (k) in the ultraviolet range at 2320 Å and at 2700 Å as well as to the R-value giving the ratio of the respective *k* values[1,2].

Ultraviolet absorption is associated with unsaturated chromophores. When single or unconjugated, these do not give rise to appreciable absorption in the usual U-V range, but when conjugated they show intense selective absorption. Conjugated double bonds appear after oxiditative changes in oils containing the naturally occurring unconjugated polyethenoid acids[3].

In cases where no oxidative changes occur a pair of double bonds may be rearranged so as to form a conjugated system and then too selective absorption will appear in the U-V region. For instance, by heating in alkali (alkaline isomerisation) poly-unsaturated fatty acids are converted into conjugated isomers and the intensity of the resulting absorption can be used as a measure of the concentration of the acids formed. Conjugated dienes, derivatives of lineoleic acid, show maximum absorption near 2300 Å, whereas conjugated triethenoid acids (isomers of linolenic acid) give this maximum at approximately 2700 Å[4].

Results of experiments in our department have shown the oil of locally grown olives to be practically free of linolenic acid[5], while soybean oil contains approximately 7% of the nutritionally essential linolenic acid. It has also been shown by Hillinger in our department[6] that quality indices derived by investigators of North African olive oils[7,8] can be applied to local olive oils. Refined olive oil shows the same low absorption at 2700 Å both before and after alkaline isomerisation, whereas the adulterated product gives an appreciably higher absorption after isomerisation. Figure 1 shows the specific absorption coefficient at 2700 Å of virgin olive oil and of the same oil after adulteration with different amounts of refined soybean oil.

Various steps in oil processing can be checked with the aid of spectrophotometric U-V absorption methods[9]. Virgin olive oil shows no typical absorption at 2700 Å, whereas refined olive oil gives the fingerprints of conjugated chromophores appearing during the technological treatment. For one combination of virgin and refined olive oil Table I shows typical figures.

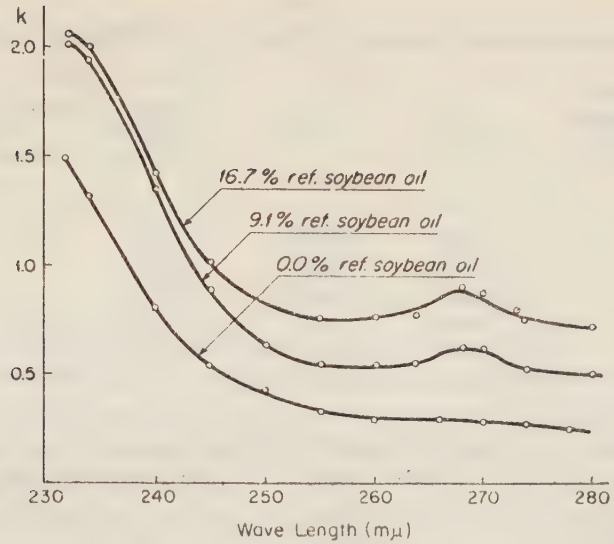

Figure 1

Specific absorption coefficients (k) for mixtures of virgin olive oil and refined Soybean oil

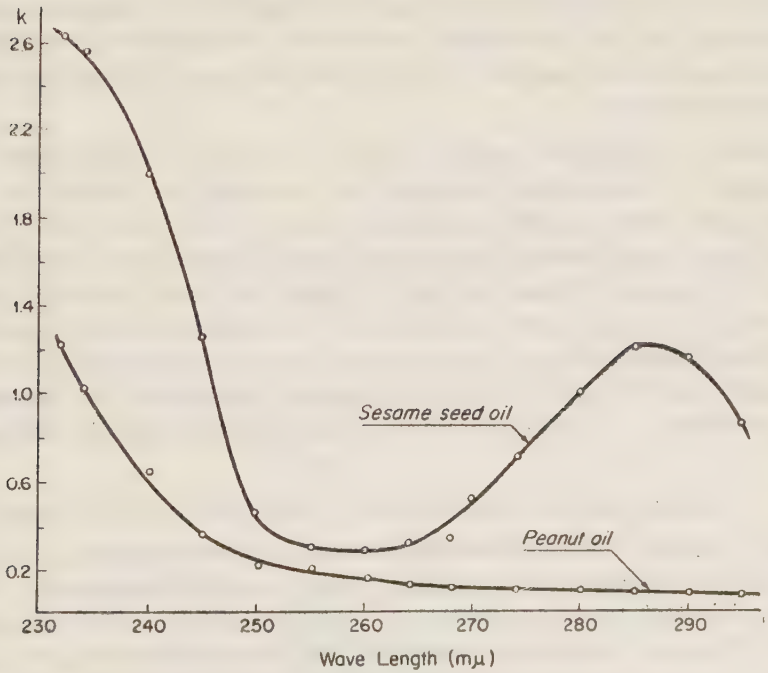

Figure 2

Specific absorption coefficients (k) for sesame seed and peanut oil

TABLE I

Changes of specific absorption coefficients of virgin olive oil adulterated with refined olive oil

Per cent (w/w) addition of refined olive oil to virgin olive oil	k 2320 Å	k 2700 Å	$\frac{k\ 2320\ Å}{k\ 2700\ Å}$ *R*-value	Per cent (w/w) adulteration of virgin olive oil with refined olive oil found according to k 2700
0	2.85	0.16	17.8	0
6.5	2.98	0.20	14.9	6
12.5	2.99	0.23	13.0	10
22.5	3.00	0.30	10.0	21
30.0	3.09	0.36	8.6	30

A broad survey of olive oil produced from locally grown olives may further substantiate the applicability of this method for determining adulteration of virgin olive oil. The drawback of this method is its lack of specificity, i.e. the method does not permit the determination of the refined oil used for the adulteration.

2. ADULTERATION OF SESAME PRODUCTS WITH PEANUTS

Tchina, a product of crushed sesame seed previously roasted, is a popular oily food in Israel. By mixing tchina with boiled sugar the local industry produces a nutritious sweet especially rich in the essential amino acid methionine[10]. As sesame seeds are more expensive than peanuts, the adulteration of sesame products with peanuts occurs rather frequently.

The presence of peanuts in sesame products may be verified by the rather cumbersome method of determining arachidic acid according to Renard[11] or by the microscopic detection of definite peanut structures[12]. We found that sesame oil, extracted from raw or roasted seeds shows a very definite broad absorption band between the triene and tetraene region[13]. Whether this band stems from a mixture of geometrical isomers of polyethenoid acids or from artefacts cannot yet be stated. Nevertheless, Figure 2 shows that such a peak does not occur with peanut oil. Thus a decrease in the height of this typical absorption band for the oil extracted from pure sesame seeds, can be used to determine the extent of adulteration with peanuts.

3. CHANGES IN OILS AND OIL CONTAINING PRODUCTS DURING STORAGE

Oxidative changes in oils are generally followed by determination of the peroxide value and more recently by complexing secondary oxidation products of the oil (a malondialdehyde tautomer related to epihydrinaldehyde) with 2-thiobarbituric acid[14,15]. We were interested in comparing the results obtained by those methods with the specific absorption coefficient at 2320 and 2700 Å. Table II shows the results of such an experiment with refined soybean oil (FFA 0.1%). The Activated

TABLE II

Comparison of various testing methods for differently heated soybean oil

Total hours of heating at 85°C	Therefrom hours of aerobic heating	Therefrom hours of anaerobic heating	Peroxide value	T.B.A. (14)	k 2320Å	k 2700Å
0	0	0	2.0	0.0	3.7	2.9
57	57	0	45.5	0.9	8.8	3.2
92	92	0	72.0	0.7	14.0	3.3
92	57	35	1.0	0.8	7.6	5.4

Oxygen Method[16] was used for the aerobic oxidation of the oil at 85°C for different periods of time and the results compared with these obtained by heating the same oil at the same temperature first aerobically and afterwards anaerobically.

The results show that aerobic oxidation of oil can be followed up by determining the peroxide value and the specific absorption at 2320 Å. The information given by these methods loses its value when heating of the oil at the comparatively low temperature of 85°C is carried out with exclusion of air. In the latter case, only the absorption at 2700 Å shows a trend which makes quality testing meaningful in this

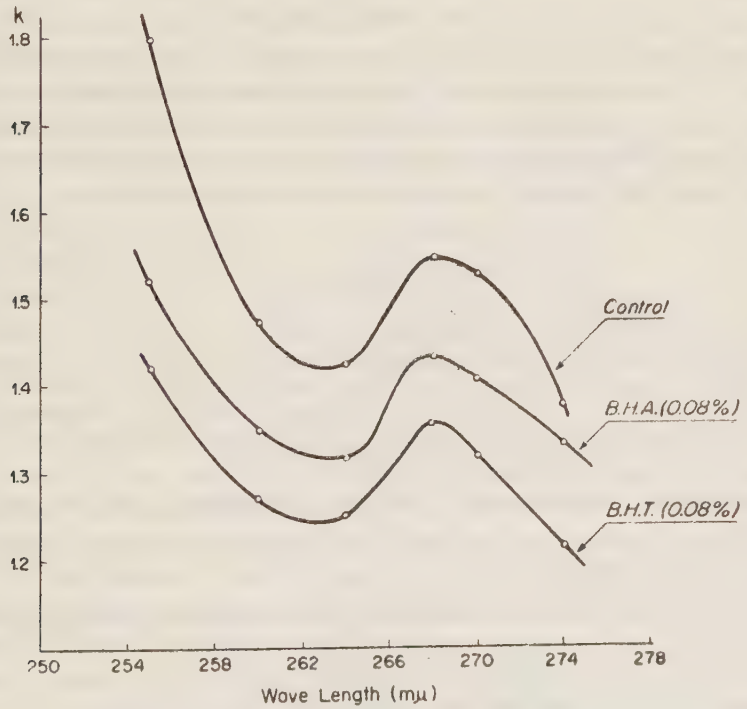

Figure 3

Values of the specific absorption coefficient (k) for hardened cottonseed oil extracted from biscuits after storage during 12 weeks at 37°C

connection. It seems that under the conditions of our experiments breakdown products of the oil reactive with thiobarbituric acid did not appear since the T.B.Å. values give no clue of any undesirable change.

As canning of fatty foods entails heating at higher temperatures during a shorter time than those tested above, we intend to continue our experiments by varying the conditions accordingly. A closer scrutiny of these methods may also be of importance for the evaluation of storage changes in fatty foods where generally lower temperatures but much longer "heating" times are used.

In experiments with citrus flavonoids[17] we showed the importance of a reliable method for determining the antioxidative properties of possible innocuous oil additives. The value of the spectrophotometric method for this purpose is also evident from the graphs shown in Figure 3 representing the results of storage tests with biscuits baked with hardened cottonseed oil with and without added antioxidants. Whereas the oil with antioxidants extracted from the biscuits after 12 weeks storage at 37°C gave a lower peroxide and T.B.A. value than at the beginning of the storage period, the specific absorption coefficient at 2700 Å showed that some oxidative change undetected by other methods took place.

4. CONCLUDING REMARKS

To sum up it may be said that spectrophotometric U-V methods provide a useful instrument for quality control and for the detection of adulteration in oils and fatty foods as shown in experiments with olive and soybean oil as well as with sesame seeds and peanuts. In the light of the results obtained the necessity for a reappraisal of the peroxide and thiobarbituric acid methods is apparent.

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EDIBLE USES OF SOYBEAN LIPIDS

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1. SOYBEAN OILS

With the development of the soybean crop in the U.S., soybean oil has become the major oil used in that country, at least for edible purposes.

There are three specific uses for soybean oil in the U.S.A. First, as a liquid oil used in the manufacture of salad dressings, for mayonnaise, and a salad oil. This oil competes with winterized cottonseed oil and corn oil.

The second most important use of soybean oil in the U.S.A. is in the manufacture of shortening. Originally, shortening was used in the manufacture of pie crust and pastry, and the principal fat used for that purpose was lard. From time to time shortages of lard occurred, and some enterprising manufacturers who wished to meet public demand mixed lard with cottonseed oil. That was over 80 years ago. Gradually it was learned how to make a shortening without lard by mixing cottonseed oil hydrogenated to a melting point substantially above 50°C with liquid cottonseed oil, deodorizing the mixture, and chilling the product on lard rolls to give a plastic material to be used by the baker and the housewife. Later a process was developed for hardening the whole oil rather than only a portion of it, it being quite obvious that a liquid oil unhardened is less stable than one which is hydrogenated. The process of hardening the oil altogether resulted in a very stable cooking fat.

Most of the materials sold as shortening consist of vegetable oils. Originally it was necessary to use almost exclusively cottonseed oil in shortening, but as soybean oil became available in large quantities, the price differential between these oils increased to a substantial figure, so that an effort had to be made to learn how to make shortening out of both cottonseed and soybean oils. The final product being slightly different. The difficulties were surmounted and it is now possible to make a shortening containing 75 percent soybean oil and 25 percent cottonseed oil. Certain physical properties of hardened soybean oil make it impossible at the present time to produce a shortening containing 100 percent soybean oil. The presence of a small amount oe cottonseed oil confers very desirable properties on the shortening wihch cannot bf achieved with soybean oil alone.

The third use of soybean oil is in the manufacture of margarine. This product contains, under U.S. specifications, approximately 80 percent of fat, about 18 percent of skimmed milk which has been cultured, and 2 percent of minor constituents, such as salt, vitamins, etc. Originally margarine was made with peanut and coconut oils. The cost of these imported oils rose to such a height that the manufacturers of margarine in the U.S.A., found themselves unable to make a profit because the consumers were used to a low-priced product. Therefore it became necessary for the industry to learn how to eliminate the expensive imported oils and at the same time make a margarine which would meet the public taste. This was successfully accomplished in 1935, and production of margarine began containing 100 percent cottonseed oil.

Later it became necessary to use soybean oil, as well as cottonseed, as was the case with shortening. Again, a formula has been developed in which soybean oil is the major constituent of margarine. The normal proportion is about 75 percent soybean and 25 percent cottonseed oil hardened together. The presence of a certain amount of cottonseed oil is necessary to give the margarine the desired physical qualities and stability.

2. SOYBEAN LECITHIN

An additional produce obtained from soybean is lecithin. Up to the time of the development of the soybean industry it was more or less a scientific curiosity. It occurred in egg yolk and brain tissue, and its price was $3.00 a pound or more. When it was found that a certain amount of lecithin could be extracted from soybean oil, production developed very quickly and the price came down.

Lecithin is used in margarine extensively as an anti-spattering agent, and also as a stabilizer in chocolate to prevent bloom on the chocolate bar. When lecithin is added the chocolate retains its fresh color and appetizing appearance. Otherwise it assumes a greyish color and does not look appetizing. I might add that a recent development in the U.S.A., increasing rather rapidly, has been the use of lecithin as a food supplement. It is possible today to buy in drugstores a lecithin product which is dry and granular, containing 90 percent lecithin. A good many people take it mixed with milk or water, or even eat it on breakfast foods like an extra seasoning.

SOYA IN HUMAN NUTRITION

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The studies reported in the lecture have been completed since November, 1959. They are summarized in the following papers:

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THE SOYBEAN AS A SOURCE OF PROTEIN FOR ANIMALS AND MAN

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1. INTRODUCTION

Soybean is popularly called an oilseed, but it could just as easily be called a protein seed. Historically the major value to the human race of the soybean has been as a protein seed. The Chinese and other orientals have survived for centuries where there was little of other sources of protein, particularly animal protein, because of the way that they used the soybean. They isolated the protein from the soybean by first grinding the beans with water into a so-called "milk". Then they precipitated the protein from this "milk" by heat and by addition of sea salt, and made from this precipitate cheeses and other fermented products as well as other suitable food products. This served as their major protein supplement to the proteins in the cereal grain.

The soybean contains approximately 18 percent oil and 35 percent protein. When the oil is removed, there remains a meal that contains from 46 to over 50 percent protein depending upon the amount of hulls that are removed. Hence, the soybean contains a large percentage of protein to begin with and this percentage is increased when the oil is removed.

Not only is the soybean a good source of large quantities of protein, but the protein of the soybean contains most of the amino acids that the human being requires in good supply. The proteins of the cereal grain, which are a major source of proteins to people who obtain most of their energy from carbohydrates are deficient in lysine in particular. The soybean is particularly rich in lysine and therefore supplements the proteins of the cereal grain both in amount and in quality so that the mixture of the two has good nutritive value. The advantage of legumes in general as a source of protein is their high lysine content.

Soybean meal is deficient in another amino acid, methionine, and in certain diets addition of other sources of methionine improves the performance of food mixtures containing large amounts of soybean meal.

2. SOYBEAN MEAL AS A PROTEIN SUPPLEMENT FOR POULTRY SEED

Soybean meal is used primarily as a source of protein supplement for poultry. It is no accident that the poultry industry in Israel grew as the soybean industry grew. The growth of the one demanded the growth of the other. The poultry industry

supplied an outlet for the product of the soybeans and the soybean industry provided the supplement needed in poultry feeds. This is exactly what happened in the United States where the rise of the poultry industry coincided with the development off the soybean as a major crop.

But the use of the soybean meal as an ingredient for poultry requires that it be processed properly. First of all the meal should contain as little fiber as possible and this means that the processing operation should be adjusted to remove the hulls so as to yield a product that contains at least 50 percent protein. Secondly, the soybean contains materials which interfere with growth. They have been variously called trypsin inhibitors, hemagglutanins, and others. Fortunately these are destroyed by heat, and therefore, in the processing of the soybeans to yield a meal suitable for feeding to poultry, the meal must be further heated (toasted) in order to remove the deleterious factors. But heating is a delicate process, because overheating destroys the protein value; hence, just the right amount of heat must be applied. This emphasizes the important rule of methods of measurement of extensive heat damage as an aid in the development of soybean meal suitable for use in poultry feed.

The oilseed processing industry of Israel has the equipment and the understanding to produce suitable products from soybeans for the poultry industry. The scientists in Israel understand the need for measuring protein quality and have developed methods that can be used for such purposes and are working on improving these methods. The poultry industry of Israel has used soybean meal extensively but probably can use more quantities of the meal instead of more expensive sources of protein to reduce further the cost of poultry and egg production in Israel.

3. SOYBEAN MEAL AND HUMAN NUTRITION

Let us go back to the ancient use of the soybean by the orientals and consider it in terms of cost of protein. The Medical Research Council of the United States has suggested that every person should have in his diet at least 30 grams of animal protein per day. Actually 50 percent of the world's population gets less than 15 grams of animal protein per day and 25 percent gets less than 30 grams of animal protein per day. At least three quarters of the world's population does not get as much animal protein as is considered necessary and it is expected that this proportion will increse rather than decrease. This does not mean that three quarters of the world's population are not well fed; there are other solutions than that of using the very excellent but more expensive animal protein. One solution is the direct use of vegetable protein as human food. One example is to use soybean flour as a supplement to bread to increase protein content. Another possibility being explored by Scrimshaw in Guatemala is to supplement corn flour with cottonseed flour. But there are many areas where soybean flour or other oilseed flours cannot be used in sufficiently high concentrations for effective supplementation. Although the flours contain 50 percent protein the 50 percent of other materials contributes flavours and colors and other properties

which make it impossible to use too large an amount for supplementation purposes. Thus, there is a limit to the amount of soybean flour that can be put into bread without interfering seriously with the quality of the bread. Surely as much soybean flour as can be incorporated should be, and Israel is to be congratulated for being one of the very few countries in the world which by law introduces a certain amount of soybean flour into bread.

Another approach, which is the modern counterpart of the ancient approach, is to isolate the protein from soybeans or other seed materials by modern means so as to yield a protein that has no odor, taste, or color, and which can be incorporated into soups, bread, and other food products as well as into fermented products. This also has the advantage of eliminating heating and of eliminating toxic materials without use of heat. Such a process once developed might conceivably yield protein of good quality that would be less expensive than protein from animal sources.

At the present time this process is much more expensive than it should be. The basic principles of such a process depend on knowledge and understanding of protein chemistry; as that knowledge, particularly of the chemistry of seed protein, advances and as the technology of isolating this protein improves, it should be possible to produce these new high quality protein products cheaply enough to provide an important source of protein for Israel.

4. CONCLUDING REMARKS

The soybean has brought to Israel a great new source of oil and protein. It has brought about a remarkable development of the oil processing industry, its modernization and its expansion. The soybean has brought large quantities of good oil to Israel to be used domestically and as an export material, and it has made possible the large scale poultry industry. Actually the introduction of the soy-bean into Israel as a major food item may be considered a historic development from the point of view of Israel's food economy.

But the introduction of the soybean into Israel creates a potential for new sources of food which will depend on higher technological advancement and more sophistication both in protein manufacture and in protein use. This indeed is a challenge to the science and industry of this country.

TECHNOLOGICAL ASPECT OF THE UTILIZATION OF SOY PROTEINS

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1. INTRODUCTION

The attractive features of isolated soya protein when compared to soya flour, are mainly its higher protein content, the absence of a bitter flavour, inhibitors, its white colour and its relative insensibility to browning reactions.

Although it has been shown that the supplementation of wheat bread with 12 percent soy flour greatly improves its nutritive value,[1] such bread cannot be accepted as white bread. Its volume is seriously impaired, its taste is changed, (some like, it, some do not), and it acquires a yellowish or dark hue. As isolated soya protein is odorless and tasteless, it does not change the organoleptic qualities of the bread and the dough characteristics may even be improved. It is well known that the addition of properly prepared soy flour improves the quality of the dough in that it makes it less sensitive to the effect of oxidizing improvers, and also increases the mixing tolerance. It may be assumed that no impairment of the loaf volume or organoleptic qualities is to be expected when properly processed isolated soy protein is added to bread is reasonable amounts.

2. ISOLATION AND UTILISATION OF SOY PROTEINS AND BY-PRODUCTS

Soy protein is soluble at both low and high pH values, displaying minimum solubility at 4.6 to 4.1[2]. Therefore it can be extracted from soybean by acid or alkaline treatment. Alkaline extraction is preferred, pH 7–8 being adequate[3]. Of course, better extraction could be obtained at higher pH values [4,5,6], but under such conditions foreign substances are also extracted and this may lower the purity of the product. Protein extracted at too high values of pH are found to be also darker in colour.

After extraction a protein solution is obtained which is freed from insoluble substances high in fiber and other constituents by filtration, and acidified back to pH 4.6 where the protein is precipitated in the form of a tasteless curd which is

filtered, washed and dried. This is a commercial product which can also be marketed in other forms. For instance, it can be redissolved in alkali and spray dried in the form of proteinates,[7] or it can be partially hydrolysed[8] to give products of different properties.

The soya protein isolates and their derivatives have been used more because of their mechanical properties rather than because of their nutritional value. They are good thickeners for whipped cream, ice cream[1], dairy products[9], etc. One of their uses is as binders for water and fat in meat products such as frankfurters and meat loaves[3]. When such products are fried or cooked, the meat fat is melted and the sausage shrinks. This can be avoided by addition of binders such as soy protein or milk solids. These properties of soy protein are being utilized in the U.S. in the manufacture of meat and fish sausages.

One factor has been responsible for the rather limited use of soybean protein and that is its cost. The protein isolates are sold for up to 40 cents a pound. The price per pound of crude protein is about 10 cents, and the difference of 30 cents indicates a rather high production cost. However, this is expected to decrease when new uses are found and the product is produced in large quantities.

The second reason for this product being rather expensive is that so far no use has been found for by-products. It may well be possible for example to utilise the whey which remains after the precipitation of proteins in microbiological processes.

At the Haifa Technion we are planning to undertake research on three aspects of soya protein production. One is investigation of the optimum conditions for extraction and precipitation. At present the soya flour suspension used for extraction contains about 5 percent soya, which means that large volumes of liquids have to be treated, which affects production costs. We want to see if the process can be carried out with more concentrated suspension so as to reduce the volume of liquid to be treated and to obtain a more utilizable whey. The second point on which we are planning to work is the drying process, in which some browning and denaturation of the protein is generally caused and where the nutrition value is most likely impaired. We want to try to utilise methods that have been successfully used in drying other protein substances, such as fish meal[10]. The third point to be investigated will be the utilization of the by-products.

These investigations may indicate means of producing the protein at a cost low enough to make its use feasible even in the field of mass-nutrition.

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RECENT RESEARCH ON SOY PROTEINS

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1. INTRODUCTION

In recent years spectacular advances have been made in the study of proteins and we are rapidly gaining a much better understanding as to what proteins are, and what they do. What is rather more important, we are beginning to see in which ways they perform the varied and intricate tasks assigned to them by nature. Only 15 or even 10 years ago we knew very little about these important substances, without which no organism can live; it was known that they were complex, big molecules, and that these molecules were composed of relatively simple building stones, the amino acids. Some twenty of these amino acids have been isolated and studied in detail, but not until recently was it possible to say exactly how much of this or that amino acid entered into the constitution of a certain protein, be it a blood protein or milk protein.

Certainly we knew nothing as to how the amino acids were arranged alongside each other in the long protein molecule, and could say litt'e as to the effect of the composition and structure of proteins on their various properties, such as solubility, behaviour upon heating, nutritive value or other biological properties.

However, with the development of modern techniques for the separation and purification of proteins, as well as for the accurate analysis of their amino acid constituents, many of the problems of the chemistry and biology of proteins have been and are being solved. Not only is it possible by these new techniques to prepare so-called "pure" proteins and to obtain an accurate analysis of their composition, but we can also tell, by the use of cheap equipment – a few glass jars, some sheets of filter paper and a couple of chemical reagents – how the amino acids are arranged in the protein molecule; (incidentally, this can also be done mechanically, using a machine developed by a U.S. scientist and put on the market last year, but this machine costs about $12,000). In fact, one of the smallest protein molecules, that of the hormone insulin used in the treatment of diabetes, which is built of 51 amino acid units combined together, has been completely mapped. This work gained worldwide recognition by the award last year of the Nobel prize to the British chemist, Dr. F. Sanger, who for ten years had patiently studied the insulin molecule. Some other proteins are now being mapped, among them hemoglobin, – the red protein of our blood cells, and it is of interest that certain blood diseases can now

be traced to the replacement of a single amino acid out of the hundreds which form the long chains of hemoglobin molecules.

This is only one example of the effect of a change in the composition of a protein molecule on its biological properties. In this case the change of one amino acid transforms a normal protein to one which produces a disease. Indeed, many examples can now be cited of the effects which structural changes have on the various properties of proteins.

So far we have been discussing proteins proper. But as in any other field, much can also be learned from the study of models, more simple substances, which are prepared synthetically and may serve as models for proteins.

Here again the main advances have been made in the last decade or so. It is true that as yet we do not know how to compete with nature and prepare synthetic proteins in the laboratory. This is still an unattainable goal, in view of the complexity of the protein molecule. But mainly due to the work of E. Katchalski and his associates at Rehovot we can now prepare large molecules made of long chains of amino acids. These synthetic polypeptides, as they are called, can be made of one type of amino acid, or two or three linked together. It is true that these are not real proteins, but they have many properties in common with proteins – solubility, effect on various cell constituents, digestibility by enzymes and so on. Through the study of these models, we can now test which amino acids effect the properties of proteins in solution, and in what way. We can say for example why certain proteins are not digested by the enzymes of the gastric juice and why others are.

Another field in which work is being done in the Department of Biophysics in Rehovot is the development of experimental techniques by which we can attach chains of amino acids to proteins thus obtaining polypeptides attached to proteins, the so-called "polypeptidyl proteins". Apart from the theoretical interest in such modified proteins, we may have here a tool for specific modification of the nutritional properties of proteins, a point to which I will return later.

2. COMPOSITION AND NUTRITIONAL VALUE OF SOY PROTEINS

The impact of all these advances on the study of plant proteins, and especially of soy proteins, which may prove so essential to the future of mankind on this planet, has been very limited. In many respects the study of soy proteins is lagging behind the advancing front of protein chemistry and our knowledge concerning their nature is very meagre indeed. Most of the new techniques just mentioned have barely been applied to the field of soy proteins.

Thus, though some studies have been made on the fractionation of soy proteins by acids, bases and salt solutions, no single purified protein fraction has yet been isolated. From the recent investigations of Briggs and Mann, and of Dr. Smith and his colleagues at the Northern Regional Research Laboratory, it is known that defatted soybean meal contains at least eight different protein components. That this number may be even higher is suggested by biological tests, which reveal the

presence of various enzymes, several (at least two) trypsin inhibitors, and proteins exhibiting other types of biological activities.

The major fraction, a globulin type protein isolated as early as 1898 by Osborne and Campbell and named glycinin, comprises about 75% of the total soy protein. However, even this fraction has not been prepared in a reasonably pure and homogeneous form, free from other protein components of the soybean. Some crude protein fractions, obtained from the soluble soybean protein by acid precipitation and by heat coagulation, have been analysed very recently for their amino acid composition, by the modern technique of ion exchange chromatography. One interesting finding which emerged from this study was that the heat coagulable protein of whey, which was 7 – 9% of the total soluble protein, contained larger amounts of nearly all the nutritionally assential amino acids, than the total water soluble protein. This fraction, therefore, was of a higher nutritional value than the other ones.

However, even these most recent analyses left unsolved one of the major problems concerned with the nutritional value of soy proteins and of plant proteins in general. The problem stems from the fact that the differences in amino acid content of plant and animal are not sufficient to explain the higher nutritional value of animal proteins. One clue to this problem may be found in the studies of A. Bondi and Yehudith Birk of the Faculty of Agricultute of the Hebrew University. They found that the various plant proteins, including soy proteins, cannot be digested completely by enzymes of the digestive tract. Animal proteins, on the contrary, are fully digested. Other differences between plant and animal proteins do, however, certainly exist, and may be found in future studies.

I have presented here a very brief and incomplete summary of some of our knowledge about soy proteins. It is clear that much needs to be done, and that there are many interesting problems to be solved – problems relating to physical characteristics of soy proteins, and to their chemical and biological properties.

Such studies are not only of theoretical or academic interest. A basic study of soybean proteins is essential in order to provide ways for improving feed efficiency of soybean meal, and for development of new applications for soy proteins. Present processes for utilization of these proteins are already based on theoretical knowledge gained in the past. Thus, very recently an English company, British Glues and Chemicals Ltd. began to operate a new process for the isolation of purified soybean proteins: in announcing the process the company pointed out that the development of the new process was based on studies on the solubility of soybean proteins made in the early thirties by the noted British protein chemists, Chibnall and Tristram.

3. SUGGESTED LINES FOR FUTURE RESEARCH

There is a great need for basic information about the soybean proteins and the following are some of the ways in which the problem can be attacked using the modern techniques of protein chemistry now available:

a) Improved methods for the analysis of soybean meal and purified soybean proteins (e.g. amino acid composition) should be developed; these methods may give a reliable measure of the nutritional value of these proteins, as well as of their suitability for processing of various food, feed and other purposes.

b) The soybean protein fractions should be studied extensively both physically and chemically. Studies should include solubility data, the effect of various ions, potentiometric titrations, ultracentrifugation, etc. These may lead to the develoment of mild methodes for extracting pure proteins, in high yield, free from colour impurities, inhibitors of digestion, etc. In addition, such studies may lead to improved criteria for the selection of seed species containing superior protein constituents extractable in high yield under mild conditions.

c) There is also wide scope for the investigation of chemical modification of soy proteins aimed at improving their nutritional qualities, and here I would like to go into some detail, since these ideas are new and have not been tested as yet. For example, there are now simple chemical methods by which one can break specific bonds in the protein molecule. By these methods, it may perhaps be possible to break the bonds present in the part of the soybean protein molecules which have been found, in the studies of Bondi and Birk referred to earlier, to be resistant to digestion by enzymes. Such treatment, if successful, will undoubtedly lead to complete digestibility of soy proteins and to considerable increase in their nutritive value.

Recent studies on synthetic polypeptides and polypetidyl proteins carried out in the Department of Biophysics at the Weizmann Institute raise still another possibility for increasing the nutritional value of soy proteins, as well as other proteins which are deficient in any of the nutritionally essential amino acids. As is well known, the addition of synthetic amino acids to foods has been in practice for some time. Thus synthetic lysine is added to bread which is deficient in this nutritionally important amino acid. Soybeans lack another amino acid, namely methionone, and this can also be added to soybean meal, in order to increase its value. However, adding an amino acid to a protein is a rather inefficient way of improving its nutritional value. The reason for this is simple: when the food so fortified reaches the digestive tract, the amino acid added is ready for absorption into the blood ,and is absorbed immediately; the protein, on the other hand, has still a long way to go before it can be absorbed, since it has to be digested first, a process taking a few hours. As a result, the blood first gets the essential amino acid added, e.g. lysine in the case of bread, or methionine in the case of soy protein, while the other amino acids reach the blood several hours later. Now it has been known for more than a decade that for the proper utilization of essential amino acids by the body, all of them have to be supplied simultaneously; when supplied at different times, as in the example just mentioned, the body cannot utilize the amino acids properly. It appears that if one could bind the added amino acid to the deficient protein in such a way as to ensure its being released more slowly in the digestive tract, simultaneously with the other amino

acids of the food proteins, one could benefit much more from this addition. That this possibility can be tested is clear from the studies made in our laboratory, where techniques have been developed by which methionine can be bound in "natural" peptide bonds to soy proteins, and the nutritional value of the polymethionyl-protein so obtained can be studied, both by digestion experiments with enzymes, and by studies with animals.

In conclusion I would like to point out again that though the highly nutritional soy proteins are used extensively in animal feed there is still considerable scope for expanding and improving their utilization. Such improvement and expansion will only be possible if we gain a better and more detailed knowledge of their fundamental properties, and modern techniques offer us the tools with which to achieve such knowledge.

UTILIZATION OF BY-PRODUCTS OF THE SOYBEAN OIL INDUSTRY FOR POULTRY FEED

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1. EXPERIMENTS IN POULTRY FEED SUPPLEMENTATION WITH FATS

Energy – and fatty substances are added to poultry rations only for the sake of energy–does not increase the productivity of chickens. It does not give us more eggs per bird or more meat on broilers, but it does decrease feed consumption. In other words, high-energy rations improve feed conversion: in layers we get more eggs per kilogram feed, and in broilers we get more live weight per kilogram feed. Consequently when speaking about the advantages of supplementing poultry rations with fatty substances, we are only dealing with feed conversion or feed utilization.

In our two experiments, we have tried seven different fatty supplements. Two of these served more or less as controls, one being beef tallow (imported from the United States for local soap production), and the second being an American feeding oil (Marcol 75). The others were local products of refining soya oil, and of special interest for us, such as crude oil, acidulated soapstock, "dried" lecithin,a mixture of acidulated soapstock and lecithin (half and half), and straight untreated soapstock (just to see how it compares with the acidulated product).

Due to good agreement between both experiments (although conducted during different seasons and with different breeds of chicks) I can summarize very simply and say, that of these seven products which were used, six gave good results in improving feed conversion. In other words, except for the regular untreated soapstock, which is no good, all the other substances gave more or less the same results in simple feeding experiments. That is to say, irrespective of whether we used beef tallow, an American commercial feeding oil, crude oil, an acidulated soapstock, lecithin, or a combination of acidulated soapstock and lecithin, we obtained a slight increase in growth rate (of doubtful statistical significance) and an improvement in feed utilization of 5–6 percent and 9–10 percent, respectively, from the addition of 3 percent and 6 percent oily supplement. The only difference found so far is that crude soya oil gave us slightly better results.

There exists some confirmation for these results from the data of Hill at Cornell, who, after experiments on energy metabolism in chicks, put degummed crude soybean oil at the very top of his list. In other words, he feels that this degummed soya

oil is even better utilized by chicks than corn oil or lard, and, as you know, corn oil and lard, at least in chicks, are considered very excellent fat supplements. He, too, puts beef tallow, soya lecithin, and acidulated soya soapstock into one class, more or less, with around 70–80 percent digestibility. In other words, we have a measure of theoretical confirmation for our practical observations with feeding chicks.

Approaching the subject from a practical point of view, and from the point of view of availability, I do not think that we can use more than 3 percent of these by-products in our chick rations, and as we have seen, this 3 percent should give us an approximately 5–6 percent improvement in feed conversion. Although a 5–6 percent improvement in feed conversion is economically very important to our agriculture, it is still such a small improvement that the average poultry farmer, who does not keep exact records, will not notice it. Therefore, the poultry instructors and the producers will have to "sell" the farmers the idea of using these by-products.

I mentioned before that equally good results were not obtained with the regular soapstock. As a matter of fact 3 percent untreated soapstock gave no benefit whatsoever. Untreated regular soapstock contains approximately 30 percent water, and water has no caloric value. Moreover, it contains a high concentration of salts, and from the technical point of view of incorporation into the feed, too, it gives us additional problems.

There is one additional advantage in adding the above oily by-products to the feed, which I didn't mention before. We know that it is an advantage, although again it may be difficult to prove it to the poultry farmers. Adding these fatty substances to the mashes will significantly decrease the dustiness of the feed, which is causing a good deal of trouble. When mashes are mixed in the regular feed mixers, or when thise mashes are added to feed troughs, or when the wind goes through our rather open chicken houses and blows along the troughs, the dustiness of the feed causes losses. And the part of the feed which is so lost naturally includes the finest dusty pieces, which may be the most expensive ingredients, such as fish meal, various vitamins and medical concentrates, all of which are very fine and dusty so that if no "binder" is added to the mash, these are the first ingredients to disappear with the wind.

2. TECHNICAL ASPECTS OF THE ADDITION OF FATS TO POULTRY FEED

In Israel every kibbutz, every moshav, and even some of the larger individual farms, all mix their own feed. A few larger commercial companies exist but they are still in the minority, and it is only now that thought is being given to the construction of relatively big feed plants, designed to serve whole districts. Therefore, the technical aspects of incorporating these substances into our mashes provide quite a problem, and have to be taken into consideration in choosing any of the oily substances mentioned above. I mentioned 7 fatty supplements; however, I am afraid that we will not import tallow or American commercial feed oil. A third supplement to be dis-

counted is degummed crude oil. Even if we assume that this oil will produce a 10 or 20 percent greater improvement than acidulated soapstock, economically the difference in price between these two materials will more than cancel out the advantage. So actually we are left with acidulated soapstock, lecithin, or any combination of the two.

For the small feed plant, which actually consists of only a hammer mill, a one-ton mixer, and in some cases a small pre-mixer as well, an oily supplement which is free-flowing at all times of the year is desirable. Although the Israeli winter isn't very harsh, it makes a difference with regard to the consistency of the above supplements. The only products which remained free-flowing last winter were the American feed oil and the crude soya oil, both of which are too expensive. In my experience, which is limited, acidulated soapstock is free-flowing in spring, summer and autumn, but even last winter (which was not particularly cold) the acidulated soapstock became rather thick and viscous, and in order to be incorporated into the mash it had to be heated. This wasn't very difficult, and any type of warming will do.

Lecithin is much more viscous, and this may cause difficulty in small feed plants. Lecithin, the "dried" lecithin that we have been using, remains viscous even in summer, hence technically it is not so easy to work with. A combination of lecithin and acidulated soapstock gives an intermediate viscosity, depending on the composition of the mixture.

Regular untreated soapstock is a very difficult product, (besides being useless), because it is very viscous, and heating makes it worse, as it is just driven off the water, leaving a sort of soft soap.

I want to emphasize that when I talked about lecithin, I meant a dried lecithin from which the excess water had been driven off. I am worried by the possibility that if we should use lecithin still containing water, it might decompose much faster and cause oxidation and rancidity. This problem might be solved by the addition of lecithin to soybean oil meal by its producer.

If the farmers could be persuaded that it is both necessary and advantageous to add these by-products to the feed, it might be possible for the producer of soybean meal to add these by-products to his meal as a specialty product. In other words, besides selling his regular soybean meal, he could market a "fattening" meal, which would contain several percent of these fatty substances.

A subsidiary problem in this connection is whether or not acidulated soapstock contains enough natural antioxidants to be marekted in barrels without the addition of stabilizers? An answer to this question is essential, if we are to use these materials during the warm Israeli summers.

Although the Israeli poultry industry tries to copy American methods, I am afraid that as far as the utilization of soapstock for feeding purposes is concerned, we cannot learn very much from the United States. In 1956 the feed industry in the United States used 150,000 tons of different fat supplements, and of these 92 percent were animal fats, the rest being vegetable fats, altogether, only two percent were

cotton and soya soapstock. Two companies in the U.S.A. make methyl esters from soapstock free fatty acids, which are a wonderful free-flowing product. I do not know whether this would be an economically sound proposition for Israel. For the present I think the problem will have to be solved more simply.

3. ECONOMIC CONSIDERATIONS

As I mentioned before, the advantages derived from adding fats to poultry rations are limited to an improvement in feed conversion. Hence the question which arises is a very simple one: by how much can we efford to raise the price of feed in order to decrease feed consumption by a certain percentage? Obviously it would be very silly to make the ration more expensive by 15 percent in order to save 10 percent feed. This consideration gives us an automatic ceiling for the price that the above fatty by-products may cost.

In the United States animal fats are used as long as they do not cost more than two and one quarter times the price of corn. In Israel we do not have corn (or rather we have only limited quantities of it); instead we use sorghum or milo corn, which resembles corn in energy content. Milo costs approximately IL 170–180 per ton; it may go up to IL 190 and sometimes down to IL 165. Accordingly, the above fatty by-products should not cost more than two and one quarter times this price, minus the extra expense to the farmer of incorporating the substances into his mash (this may include labor and electricity for slight warming.)

To sum up, I think that it can fairly be said that acidulated soapstock is a good product, and that in due time the farmers will want to use it at a reasonable price. If that is the case, we will have reached the ideal state of affairs in which the soya oil industry gets rid of a not especially desirable by-product, and the farmers obtain a desirable and economically feasible supplement.

ISRAEL SOCIETY OF FOOD AND NUTRITION SCIENCES

First Session, Tuesday morning 4.4.61 Chairman: G. ZIMMERMAN

Soybean Symposium

Comparison of chemical and biological assays of the nutritive value of soybean meals

S. HALEVY, N. FRIEDMANN AND K. GUGGENHEIM, *Laboratory of Nutrition, The Hebrew University–Hadassah Medical School, Jerusalem*

Soya meals which had undergone various procedures of processing, differing in duration of heating and moisture conditions, were studied for urease activity, cresol red absorption, hemagglutination, enzymatic liberation of α-amino nitrogen, lysine and methionine and "net protein ratio" as determined in young rats. The three first-mentioned tests may be used as a practical index of effectiveness of heating, provided that the products are not overheated. Microbiological availability of enzymatically liberated lysine and methionine correlates fairly well with the "net protein ratio" and may, therefore, serve as a rather reliable indicator of proper heat processing. Toasted meal was not found to be superior in this respect to meal which had been processed without live steam.

Nutritional evaluation in rats and humans of extraction rate of flour and its supplementation with soya meal

K. GUGGENHEIM, J. ILAN, E. PERETZ, N. FRIEDMANN, S. JOSEF AND A. GOLDBERG, *Laboratory of Nutrition, The Hebrew University–Hadassah Medical School, Jerusalem*

20 kinds of bread were prepared from flours differing in extraction rate (74, 82, 86, 90, and 95%) and fortification with soya meal (0, 6, 9, and 12%). The nutritional value of bread proteins was assessed in rats by the net protein ratio (NPR). When only bread provided dietary protein, the NPR rose as the precentage of extraction and of soya added, increased. Soya improved the nutritive value of proteins of both white and dark breads. When bread supplied only one half of dietary protein, the other half being derived from casein, neither extraction rate nor soya improved the nutritional value of the protein.

The effect of 2 kinds of bread, prepared from white and unsupplemented flour and from dark flour fortified with 5% soya meal respectively, was studied in 2 groups of adolescents comprising 96 and 88 subjects, respectively. The trial lasted 8 months. At the end of the observation period there was no appreciable difference in nutritional status and biochemical and hematological findings between the 2 groups, which could be ascribed to the bread.

On quality evaluation of protein feeds for poultry

I. Ascarelli, A. Bondi and B. Gestettner, *Faculty of Agriculture, Rehovoth, The Hebrew University of Jerusalem*

The industrial processing of protein feeds necessitates laboratory methods for their quality control. These methods render an indication of the chemical structure of the feed protein and of the changes which it undergoes during processing. Heating of cottonseed meal is necessary for the detoxication of gossypol, but overheating causes the undesirable linking of the gossypol with the ε-amino groups of lysine and diminishes therefore the availability of this amino acid[1]. The ε-amino can be determined by reaction with fluorodinitrobenzene (FDNB). The results obtained by this method do correlate with biological experiments, and with the results of the chemical index method based on the determination of protein solubility in 0.02N NaOH and of gossypol[2]. Digestion of cottonseed meal by trypsin gives similar results.

Heating of soybean meal enhances the availability of methionine for animals as shown by the *in vitro* digestion with pancreatin and the determination of the methionine in the digest [3,4].

The determination of free ε-amino groups of lysine does not show any difference between unheated and properly heated meals, only overheating brings about a reduction in ε-amino. The urease method does not differentiate between properly heated and overheated meals. The quickest and simplest method for the evaluation of soybean meals is the empirical one based on the absorption of cresol red, which increases with heating[6]. This method has been found simpler and more exact than the measurement of the antitryptic activity of soybean meal extracts on casein digestion.

The damage caused by overheating (during processing or accidental) of fish meals can be recognized by a decrease in free ε-amino groups of lysine. The amino acid composition of fish bone and scale is of lower value than that of fish meat. These low-grade proteins contain hydroxyprolin, which is found in fish meat in minute amounts. We have tested therefore to see if hydroxyprolin can be used as a negative indicator for fish meal quality, but we have not found a direct relationship between the results of the colorimetric determination[7] of hydroxyprolin and the biological values determined with chickens. Apparently hydroxyprolin-content is only one of the factors influencing fish meal quality.

In the determination of the biological value of fish meals the method proposed by Bender[8] for rats and based on the relationship between N content and water percentage of the body can be successfully used with chickens.

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The effect of chemical and enzymatic treatments of soybean meal on its digestibility *in vitro* and *in vivo*

Y. BIRK, A. BONDI AND A. GERTLER, *Faculty of Agriculture, Rehovoth, The Hebrew University of Jerusalem*

Experiments have been conducted to inactivate the soybean trypsin inhibitors (SBTI) present in soybean meal (SBM), without a simultaneous destruction of soybean proteins. Oil-free SBM and 2 SBTIs were subjected to mild HCl treatment and to digestion by pepsin and by papain. Both caused a considerable decrease (20–90%, depending on reaction conditions) of the antitryptic activity of the SBM digest. 2 crude SBTIs — Ai and Ali, acetone insoluble and alcohol insoluble factors, respectively[1] — and in some experiments also c_1, a SBTI which inhibits *Tribolium castaneum* proteolysis[2], were digested by pepsin and by papain. Pepsin diminished the antitryptic activity of both Ai and Ali and papain—only that of Ali. When dissolved in HCl *p*H 1.7—the natural medium for peptic digestion—Ali lost ~50% of its activity whereas Ai was not affected. Preliminary growth experiments with chicks and with *Tribolium castaneum* larvae fed on a raw SBM (R) and papain supplemented diet, exhibited a marked growth inhibition even when compared to the same organisms grown on a R supplemented diet only—probably due to some physiological effect of crude papain. In an attempt to prepare a SBM rich in protein and poor in antitrypsin, raw SBM was extracted by HCl *p*H 4.2 and the residues S_1 (after 1 extraction) and S_2 (after 2 successive extractions) were dried at 40°C. R, S_1 and S_2, with the respective antitryptic activities of 100%, 48% and 40%, differed inversely to the same extent when digested by pancreatin. R, S_1 and H, a properly heat processed SBM, were included in the diets of rats, chicks and *Tribolium castaneum* larvae and the gains in weight were determined. Though S_1, when compared to R, promoted considerably the growth of the organisms examined, growth promotion was much lower than that expected from the 50% decrease in antitryptic activity.

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The mechanism of soybean antitrypsin action in the growing chick

EUGENIA ALUMOT (OLOMUCKI) AND ZAFRIRA NITSAN *Department of Animal Nutrition Agricultural Research Station, Bait Dagan*

The proteolysis of chicks fed mash containing raw soybean meal was tested at ages from 1 to 8 weeks.

Tryptic digestion in the small intestine was found to be inhibited until the age of 3 weeks. At 6 weeks the enzyme activity reached almost normal values. Pancreatic hypertrophy was noted throughout the experimental period.

In view of these results, the growth depression of chicks by soybean antitrypsin can be now explained as follows:

a) unavailability of amino acids, caused by inhibition of intestinal proteolysis until the age of 3 weeks.

b) increased requirement for protein and energy due to stimulation of pancreas activity.

Influence of heating on the nutritional value of soybean meal for ruminants

H. TAGARI, I. ASCARELLI AND A. BONDI, *Faculty of Agriculture, Hebrew University, Rehovoth*

It was generally believed up to now that heating of soybean meal, although improving its nutritional value for chickens is without effect on its value for ruminants. Research carried out recently has made clear that the biochemical processes in the rumen are affected by the quality of the feed and that they are paramount in determining the feed efficiency.

When a protein is ingested, it is promptly attacked by rumen micro-organisms and undergoes at first proteolysis and deamination. The ammonia formed is utilized by bacteria and protozoa in protein biosynthesis. This protein, together with the unattacked feed protein, passes on to the intestine and is digested and utilized by the host animal. However rumen micro-organisms can utilize only partially the ammonia formed in the rumen. Excess ammonia diffuses into the blood, is converted to urea and excreted, and therefore is not utilized by the animal. The study of the above processes in the rumen of sheep fed soybean meals which have been subjected to different degrees of heating will allow the evaluation of the heat factor on protein utilization by ruminants. In the present work three kinds of soybean meal were tested, all extracted by the same procedure and then treated as follows: meal A: solvent evaporated at room temperature; meal B: solvent evaporated at 80° for 5 min.; meal C: as B, then toasted at 120° for 15 min. The daily ration consisted of 1 kg of foxtail millet hay and 200 g of one of the above-mentioned meals. Rumen content fluid was taken by suction through a stomach tube at definite times after feeding. Liberation of ammonia is much higher for soybean meal A than for soybean meal C. Ammonia values in rumen fluid after feeding of soybean meal B are close to those obtained with soybean meal A. Representative results for one of the sheep are given in Figure 1 (each curve is the average of 3 determinations). Toasting of the meal diminishes its solubility in rumen fluid and therefore restricts liberation of ammonia by micro-organisms to a range allowing better utilization. The urea levels in blood were determined in the same sheep. It was found that the daily variations in urea levels reflect the different ammonia levels found in the rumen content. Following this finding, nitrogen-balance experiments were carried out. The superiority of the toasted meal as compared to the other two is apparent from the following nitrogen balance results (average of 3 replicates) expressed in g/sheep/day: meal A 0.006, meal B 1.59 and meal C 2.10.

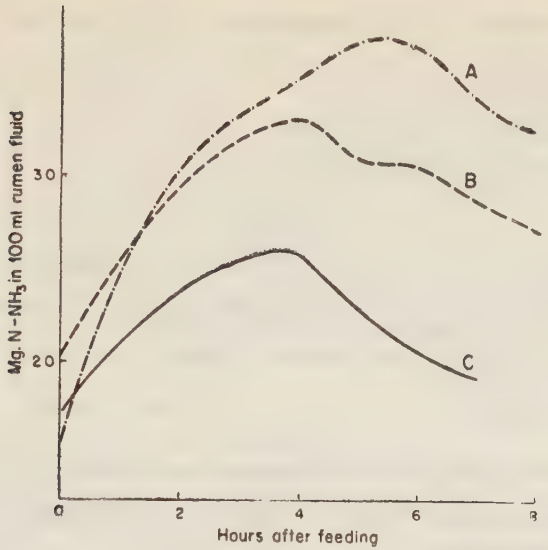

Figure 1
Ammonia levels in rumen fluid

Effect of heat on the quality of full-fat soy flour for bread-baking purposes

ZEKI BREK,* *Division of Food and Biotechnology Technion – Israel Institute of Technology, Haifa*

The effect of heat on soy products has been thoroughly investigated from the viewpoint of their nutritional value. The purpose of the present work, however, was to evaluate the effect of the heat treatment history of the soy component on the organoleptic qualities of soy bread. (Wheat bread containing also soy flour).

Full-fat soybean flakes were autoclaved under varying conditions of temperature, time and moisture content. The flakes were then air direct and ground to a fine flour. These flour samples were added to white wheat flour at the levels of 5, 10 and 15% (based on the weight of total flour mixture). Breads were baked from the resulting flour mixtures, according to test-baking procedures. The dough characteristics were recorded by means of a Brabender Farinograph.

The inclusion of moderately heated (20 minutes at 100°C) soy flour was found to increase the loaf volume by up to 27% at the 5% and 10% soy flour levels. At the 15% level, soy bread gave generally smaller loaves than the pure wheat control. Both unheated and overheated soy flours impaired the loaf volume.

The taste of soy breads was invariably found to be preferable to that of pure wheat bread, provided that the flour was not raw or overcooked.

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* The work was done at the Department of Food Technology of the Massachusetts Institute of Technology, Cambridge, Mass., U. S. A.

The farinograms revealed the following effects of soy flour on the mechanical properties of the dough:

a: The "weakening" was reduced
b: The mixing tolerance was increased
c: The "Peak time" was not influenced.

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Test on extraction and precipition in the preparation of isolated soy proteins

David Reznik and Zeki Berk, *Division of Food and Biotechnology, Technion–Israel Institute of Technology, Haifa*

This investigation was undertaken as a preliminary step towards a more advanced study of the technological aspects of the isolation of soy protein.

The following extraction media were tested, water: dilute calcium hydroxide solutions (0.003 M, 0.005 M and 0.01 M), and sodium sulfite solution (0.3% Na_2SO_3).

The most complete extraction was achieved at a temperature of 55°C for all media.

Sodium sulfite was the most efficient of all extraction media tested, from the view point of yields. However, the quality of the protein obtained was inferior, due to an after-taste dioxide.

The effect of the concentration of soybean meal suspension on the yields and extraction time was studied. The time required for an equal extraction of 75% of the total protein increased from 80 to 100 minutes when the concentration of soy meal in the suspension was increased from 5% to 10%. A further increase in suspension concentration resulted in difficulties in extraction and filtration.

The most satisfactory method for the preparation of a white, tasteless, powdered protein isolate was found to be:

a) Extraction of dehulled soybean oil meal in water (with some sodium hydroxide to neutralize the suspension to *p*H 7.0).
b) Filtration of extract from the non extracted material.
c) Precipitation of the protein curd by lowering the *p*H of the extract to *p*H 4.5.
d) Separation of the curd from the whey.
e) Resuspending the curd in water and neutralizing to *p*H 6 with dilute alkali.
f) Spray drying this suspension at a temperature of 70°–80°C.

The possibility of adding such isolates to wheat flour in the making of bread was tested. Doughs containing as little as 5% of the isolates (based on flour weight) failed to give bread of reasonable loaf volume and texture.

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Second Session, Tuesday afternoon 4.4.61 Chairman: K. GUGGENHEIM

Fruit and vegetable products

The necessity of adapting fruit and vegetable crops for industry

Z. SAMISH, *Department of Food Technology, The National and University Institute of Agriculture, Rehovoth*

The fruit and vegetable-products industry has to be supplied with suitable raw material of uniform quality if it is to manufacture quality products for a competitive international market. Specific requirements have to be fulfilled for the different processes and products, be it canning, juice production, freezing or dehydration.

Studies were carried out on different crops which are being used at present by local industry, such as peaches, plums, melons, pears, snapbeans, tomatoes, sweet corn and cucumbers.

A limited number of varieties has to be selected or developed according to desired characteristics — composition, consistency, form, colour or flavour respectively.

Enzymatic test as index of sufficient heat treatment in citrus juices

C. MANNHEIM AND SH. ZIV, *Division of Food and Biotechnology, Technion – Israel Institute of Technology, Haifa*

The feasibility of using a chemical enzymatic test, based on pectin esterase activity, as index of pasteurization in a finished product was tested. The tests were performed on citrus and grapefruit segments.

Enzymatic activity and sterility were tested simultaneously and it was found that this test can serve as an index for sufficient heat treatment.

Evaluation and adaptation of objective methods for the quality control of dates and date products

A. LUDIN, *Department of Food Technology, The National and University Institute of Agriculture, Rehovoth*

Most of the dates and date products are subject to one or more of the following treatments: dehydration, hydration, heating, cooling, freezing and storage with or

without chemical preservation. These treatments have a marked effect on the taste, texture and appearance of the product. Objective and reliable tests for the evaluation of these changes are needed.

Experiments were carried out at the Department of Food Science and Technology at the University of California, Davis. More than 40 samples of dates of the varieties Deglet-Nour, and Khadrawy were first evaluated according to the conventional methods of the Date Growers Association of California, and then analyzed for colour of whole and macerated dates by the Color-Master Colorimeter, by absorption colorimeter of ethanol extract (Klett-Summersen), moisture content by vacuum oven, and texture by a device which measures the maximal resistance offered by a given sample of pitted dates to the shearing force of rods pushed through the sample. The tests were repeated after intervals of storage at O°C.

Results showed the feasibility of making precise evaluations of the colour in the range of dark brown to light tan. Changes in colour were correlated to changes in texture.

Colour, Visual Evaluation		*Colour-Master Reading**		*Texture Meter***
	Maerz and Paul	*Filter*		
		Green	*Red*	
Roe (Tan)	Plate 12, H6	629	758	210
Light Brown	Plate 13, D7	405	555	125
Dark Brown	Plate 15, A12	231	271	55

*) Gardner Colour Plates — were standardized to read 1000. (Rd/19.8, a/10.1, b/-2.1)
**) lbs. per square inch.

The development of white spots on green pickled olives

E. Salomon and Z. Samish, *Department of Food Technology, The National and University Institute of Agriculture, Rehovoth*

The appearance of spots on green pickled olives detracts from the attractiveness of the product and thus reduces the export value of this product.

Treatment of olives before fermentation affected markedly the rate of spot formation.

The varieties Nuovo-di-Sicrone and Sde-Eliyahu were the most sensitive among the seven varieties tested.

Research on the origin, composition and quality of the white spots showed that they consist of *Lactobacillus plantarum* colonies. These colonies develop within the fruit lenticells to which nutrients flow from the surrounding tissue.

The size and number of open lenticells of the fresh olives were found to be correlated with the size and number of white spots upon the fermented fruits in each variety.

Flavour recovery from alicant and muscat grape juice

H. C. MANNHEIM, C. GUR-ARIEH AND G. ZIMMERMANN, *Division of Food and Biotechnology, Technion–Israel Institute of Technology, Haifa*

A flavour recovery unit was built and tested. The feasibility of grape juice flavour recovery from two Israeli grape varieties was investigated and found feasible. Utilization of natural grape juice flavours, obtained in the recovery unit, for the manufacture of grape soft drinks was also studied.

Suitability of zagiv prunes to dehydration

A. LUDIN AND GAD FEINSTEIN, *Department of Food Technology, The National and University Institute of Agriculture, Rehovoth*

The Zagiv prune which is grown most extensively in the hilly districts can be used for dehydration as well as for candying, even though this variety is less aromatic than the "French" prunes.

Rate of drying is very slow due to the thick peel of this variety. Pre-treatment with hot water, however, results in a far more rapid rate of drying as can also be attained by lye treatment. Sulfuring of peeled fruit, or deseeding, hastened the rate of drying but caused a conspicuous reduction in quality.

Quality and yield were highly improved by impregnation of the prunes with syrup before dehydration.

Lecture to bacteriologists and food technologists; bacteria within healty vegetables, tomatoes, cucaembers, peas and beans

R. ETINGER-TUKZYNSKA, *Institute of Agriculture, Department of Food Technology*

The surface of the vegetables was thoroughly disinfected. Aliquots of the dispersed meat of tomatoes or cucumbers, respectively the dispersed seeds of peas or beans were then transferred on different nutrient substrates.

Bacteria grew on the average on about 20% of the fruits. Usually, they were present at low concentrations but at times they occurred in large quantities.

Most of the isolated bacteria belonged to two families, Pseudomonadaceae and Enterobacteriaceae. Many produced a yellow or gold-yellow pigment on agar which did not penetrate into the substrate.

Most of the bacteria of the Enterobacteriaceae family belonged to *Aerob. cloacae*, a few to *E. intermed, E. Coli foecalis* was never found. Gram positive bacteria occurred rarely. They were *Corynebacteriaceae*, producing small yellow to greenish colonies and were very motile.

Third Session, Tuesday afternoon 4.4.61

Various subjects

Determination of juice volume in sugar beets grown in Israel

G. ZIMMERMANN AND A. ROSEN, *Division of Food and Biotechnology, Technion–Israel Institute of Technology, Haifa and Research Council for Sugar Beets, Israel Sugar Works, Afula*

The determination of sucrose concentration in sugar beets according to the generally accepted method of Sachs-Le Docte is based upon a definite volume of juice in the sugar beets.

During two seasons the juice volume in 230 samples of sugar beets grown in Israel was determined according to the methods of Krocher, Daeschner, Bauer and of Parker.

The two methods do not give identical results. The sugar concentrarion in the first mentioned method and the applied pressure in the last one, influence the juice volume determination.

Estimation of raffinose in molasses from sugar beets grown in Israel

G. ZIMMERMANN AND I. BENGERA., *Division of Food and Biotechnology, Technion–Israel Institute of Technology, Haifa*

According to standard references in the literature, sugar beets grown in hot climates do not contain raffinose.

The presence of raffinose in sugar beets is of importance for the determination of their quality. In addition, the feasability of the Steffen process for desugaring molasses depends partly on the raffinose concentration in the molasses.

By a combination of chromatographic separation and spectrophotometric determination, the presence of raffinose in molasses from sugar beets grown in Israel has been established.

The time period of safety of sterilized milk, kept without refrigeration after opening

S. H. FRANK AND R. SELIGMANN, *Ministry of Health*

A field investigation was made regarding the safety of sterilized milk in infant nutrition. The investigation was based on conditions prevailing in transient camps ("Maavara") where milk is kept without refrigeration after the opening of milk bottles.

The investigation showed that the maximal period of safety of milk kept at 27.5°C average room temperature does not exceed 14 hours i.e., the period of one day of consumption, even if every portion of milk is boiled before usage.

The effect of chlorine on chlorophyll*

J. ILANY-FEIGENBAUM AND WALTER A. MERCER, *Ministry of Commerce and Industry, Jerusalem and National Canners Association, Berkeley, California*

In connection with the recommendation of "The National Canners Association" of the U.S. on the use of chlorinated water in cleaning the raw materials for the canning industry, we investigated at the NCA Laboratories Berkeley, California, the effect of chlorine on chlorophyll, chlorophyll a chlorophyll b chlorophyllin xanthophyll and carrotene.

The following results were obtained:

1) No effect on chlorophyll has been observed with solutions containing 5 to 25 ppm chlorine. The effect of colour change is observed instantly by the addition of 30 to 50 ppm chlorine solution.
2) While chlorine seems to have almost no effect on chlorophyll a, xanthophyll and carrotene, it changes the colour of chlorophyll and chlorophyll b at higher concentrations (over 35 ppm).
3) Addition of ascorbic acid before the addition of chlorine to chlorophyll solution seems to protect the colour from the effect of chlorine at higher concentrations (30 to 50 ppm). The same effect of ascorbic acid has been observed in the case of chlorophyll b.

These experiments show that a more efficient cleaning and sterilization of the raw materials used in the canning of, especially green vegetables and coloured fruits, can be affected by using a water chlorine solution in concentrations recommended by the National Canners Association of the U.S. (5 to 20 ppm.) with no effect on their colour.

Storage life of sea-fish

A. HERZBERG AND Z. SAMISH, *Department of Food Technology, The National and University Institute of Agriculture, Rehovoth*

Indicators of deterioration — bacterial count, volatile reducing substances (V.R.S.), acidity and trimethylamine (TMA) content of fish muscle were determined in four commercial sea-fish species. It was found that TMA determination is the most practicable method of spoilage assessment giving a closer correlation to organoleptic tests of spoilage than VRS or acidity and being more rapid than bacterial count. Degree of deterioration was reduced by treating the fish with Chlortetracycline (CTC) in varying concentrations.

Freshly caught fish were dipped in sea-water containing CTS and in solutions prepared with sweet water. Concentrations used were 10, 25 and 50 parts per million CTC respectively.

Residual CTC was determined after storage in both raw and cooked fish. Determination of residual CTC by chemical methods was found to be impracticable;

* This work was carried out at the Laboratories of the National Canners Association, Berkeley, Cal.

good results were obtained by microbiological methods both in assay and in recovery tests.

Treatment with CTC approximately doubled the storage life of the fish.

Food consumption and levels of nutrition of the urban and rural population of Israel
SARAH BAVLY, *Nutrition Department, Ministry of Education and Culture*

A nutrition survey made in 1956–57 among a representative sample of urban wage and salary earners' families in Israel (which sample included 6614 families) showed an average level of nutrition which was satisfactory being in all respects above the level of 80% of the recommended allowances.

However on closer analysis sccording to income groups it appeared that within the lower income groups, a considerable percentage of the families surveyed had inadequate intakes in respect of several nutrients.

In the extreme case of the 2 lowest income groups (which comprise 11% of the representative sample surveyed) the percentage of the families which showed an inadequate nutritive intake was as follows:

Inadequate animal protein intake among	54% of these groups
Inadequate Calcium intake among	60% of these groups
Inadequate Iron intake among	25% of these groups
Inadequate Vitamin A intake among	65% of these groups
Inadequate Riboflavin intake among	50% of these groups
Inadequate Ascorbic Acid intake among	34% of these groups

This state of nutrition calls for remedial measures both in the field of nutrition education, food policy and price policy.

Another nutritional survey made in the summer of 1959 amongst a representative sample of the rural population showed that the rural population had slightly better nutritional levels than the urban population in respect of a few nutrients. This difference in favour of the rural population is mainly due to a larger consumption of fruits and vegetables in season from its own farm produce while the consumption of chicken and eggs (from its own farm) is also in most instances better than that of the urban population.

SYMPOSIUM ON FOOD FOR THE GROWING WORLD POPULATION

Monday morning, 3.4.61. 09.30–12.30 Chairman: K. GUGGENHEIM

Is it possible to increase food production in the world?

J. ARNON, *The National and University Institute of Agriculture, Rehovoth*

Marine agriculture

A. BEN-TUVIA, *Sea Fisheries Research Station, Haifa*

The seas cover 2/3 of the surface of the globe. The present fisheries along the continental shelfs exploits only a small fraction of the stock of fishes. Thus it is evident that by the application of new technical means, the food production of the seas might be considerably increased. The productivity of the seas might be better exploited by gathering the crop of phytoplankton and processing it for food. Some parts of the seas might be artificially enriched by deep water currents thus bringing minerals from the deep waters to the surface, or by the addition of minerals. Schools of fish may be detected and confined to certain areas by such means as the echo-sounder, under-water television, screens of air bubbles and the use of submarines.

Plant breeding in the service of human nutrition

CH. OPPENHEIMER, *The National and University Institute of Agriculture, Rehovoth*

The constant rise of the human population and the need to improve the nutrition of the population of most countries requires very considerable improvements in the production of foodstuffs by all possible means.

This lecture deals with one of these means — the most rational use of the existing varieties of crop plants and the development of improved varieties. It will not deal with various other ways to improve production such as: additional land use, improvement in methods of production, crop protection or industrial production of foodstuffs. We have also excluded the breeding of industrial and fodder plants.

The rational use of all the existing varieties of crop plants and the development of still better varieties are the only means to raise yield without adding to the cost of production.

In addition to breeding for higher yield-potential, varieties can be improved to meet the following conditions:

a. *Improved reaction to climatic conditions:* Resistance to extreme temperatures, resistance to drought, better use of existing conditions of light, adaptation to changes in length of day.

b. *Improved reaction to conditions of cultivation:* Efficient use of water, resistance to saline irrigation water, efficient use of nutrients, possibilities of using irrigation and artificial fertilization for high production.

c. *Resistance to pests and diseases.*

d. *Improvements in quality of product:* Higher content of valuable nutrients, lower content or absence of undesirable or noxious components.

So as to obtain the desired results it will become more and more necessary to use all available methods of plant breeding:

1. Internationally directed expeditions in plant exploration in order to obtain living herbaria of maximal completeness for all the more important crop plants.
2. Full descriptions of all the material present in these collections according to international directions, together with a genetical analysis.
3. Studies of existing varieties so as to establish their optimal use as to climate, soil and mode of cultivation.
4. Intra-specific hybridization as combination breeding according to established methods.
5. Inter-specific hybridization with known methods, and the development of improved methods to enable hitherto unsuccessful crossings to be made.
6. Breeding for higher levels of polyploidy (auto-,allo-) together with the study of the specific characters of polyploids and the means for their improvement.
7. Use of all possible mutagenic substances so as to get new material for selection and combination breeding; study of differences in mutant spectra from different mutagens; development of improved techniques for the detection of valuable physiological mutants.

The final aim would be to produce new varieties of crop plants according to specification. This goal seems at the moment to be unobtainable, but it might be possible in the not too distant future to change specific alleles in a directed manner.

Biotechnology and food production

P. MARGALITH, *Department of Microbiology, Technion–Israel Institute of Technology, Haifa*

Foods of microbial origin or microbial processing, in comparison to new developments in the fermentation industry. Yeast as source for protein and vitamin rich concentrates. Low demand prevents expansion of food-yeast industry. Vitamins and amino acids as fermentation products.

Proteins from green plant tissue

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Most plant proteins obtained from seeds are unsatisfactory from the point of view of the nutritional requirements of man. It is possible to extract proteins from leaves which are closer in their composition to human nutritional requirements. New methods to extract these proteins have lately been suggested.

A second potential food source is green algae. Great progress has lately been made in the mass culture of such algae which may make them an economically reasonable source of food and protein.

Utilization of plant proteins

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One way of approaching the problem of "food for the increasing world population" is a more efficient use of plant proteins for human food.

Four types of problems have to be solved:

1 — *Nutritional:*

The plant is generally poorer in protein than foods from animal origin. Furthermore the quality of vegetal protein is generally inferior and its utilization in the body might be less complete than that of the animal protein. Inhibitors and other toxic substances present in plants render the nutritional problem even more complicated.

2 — *Economical:*

Native vegetal proteins are much cheaper than animal proteins. However, processing-cost may be so high as to render the use of a particular vegetal protein as a food for masses, prohibitive.

3 — *Food habits:*

Replacing the animal food by new protein foods from plants will require a change in eating habits. These foods will have to be transformed to products that can be introduced into the daily diet without drastically changing such habits.

4 — *Technology:*

It is understood that the answer to all those problems lies in the technological aspects of processing. The nutritive value of the vegetal protein may be improved by processing methods (concentration, isolation, fractionnation). The processes will have to be developed with ultimate cost in mind. The transformation of plant protein to similar products in use and organoleptic qualities to milk, meat etc. will also require processing.

The need for extensive and organized research on the physico-chemical, biochemical and physiological properties of plant proteins, as well as on the development of technological processes can not be overemphasized.

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